

ELECTRONIC

EQUIPMENT

& SYSTEMS

DESIGN • DEVELOPMENT • FABRICATION

COMPANY BACKGROUND

AND

CAPABILITIES

ESS GEE inc.



1 HOLLAND AVENUE

WHITE PLAINS, N. Y.

914 WH 6-1200

ESS GEE, Inc.
White Plains, N. Y.

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COMPANY BACKGROUND
AND
CAPABILITIES

COMPANY BACKGROUND

and

CAPABILITIES INDEX

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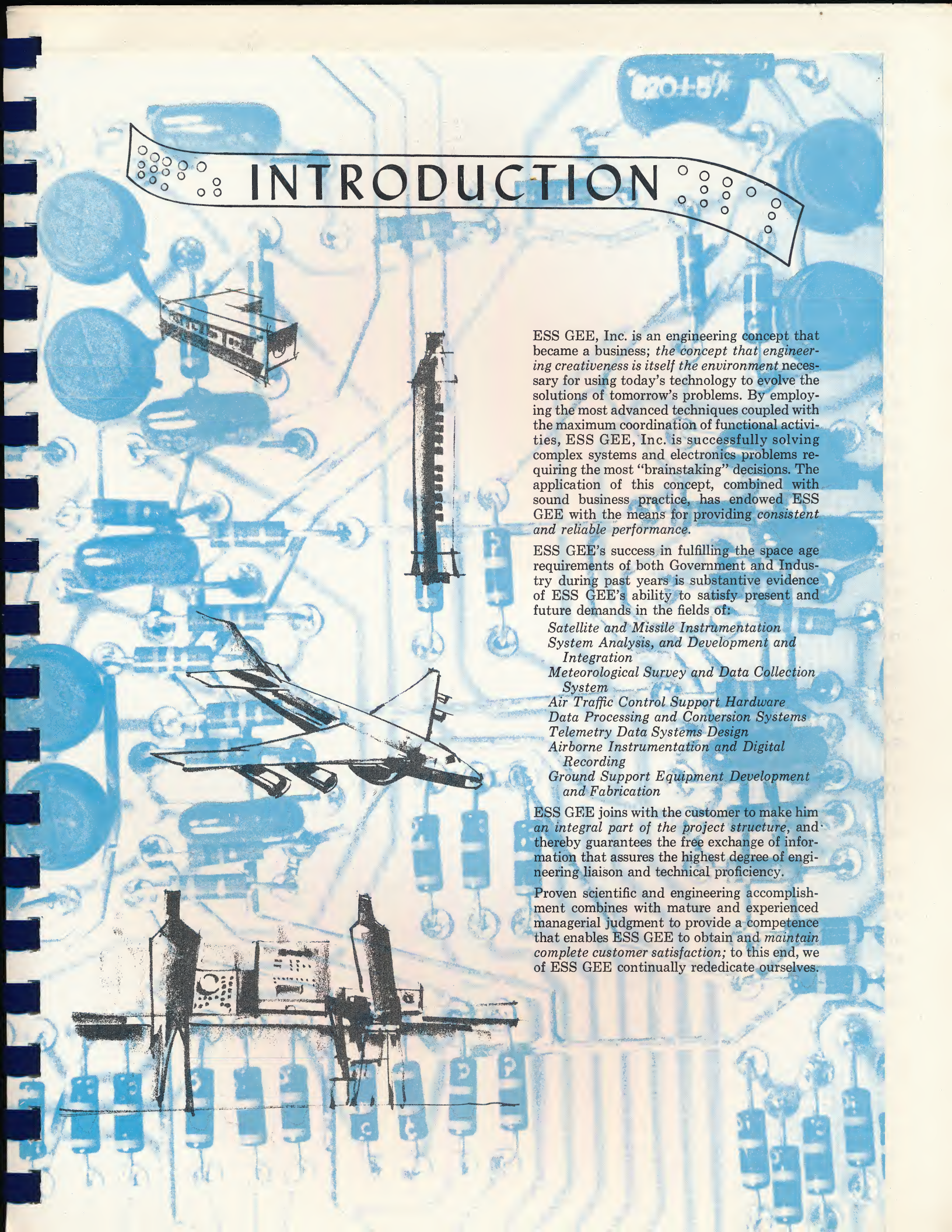
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INTRODUCTION

ESS GEE, Inc. is an engineering concept that became a business; *the concept that engineering creativeness is itself the environment necessary for using today's technology to evolve the solutions of tomorrow's problems.* By employing the most advanced techniques coupled with the maximum coordination of functional activities, ESS GEE, Inc. is successfully solving complex systems and electronics problems requiring the most "brainstaking" decisions. The application of this concept, combined with sound business practice, has endowed ESS GEE with the means for providing *consistent and reliable performance.*

ESS GEE's success in fulfilling the space age requirements of both Government and Industry during past years is substantive evidence of ESS GEE's ability to satisfy present and future demands in the fields of:

*Satellite and Missile Instrumentation
System Analysis, and Development and
Integration
Meteorological Survey and Data Collection
System
Air Traffic Control Support Hardware
Data Processing and Conversion Systems
Telemetry Data Systems Design
Airborne Instrumentation and Digital
Recording
Ground Support Equipment Development
and Fabrication*

ESS GEE joins with the customer to make him *an integral part of the project structure,* and thereby guarantees the free exchange of information that assures the highest degree of engineering liaison and technical proficiency.

Proven scientific and engineering accomplishment combines with mature and experienced managerial judgment to provide a competence that enables ESS GEE to obtain and *maintain complete customer satisfaction;* to this end, we of ESS GEE continually rededicate ourselves.

ESS GEE inc.



IS RAPIDLY GROWING IN STATURE AS A DEPENDABLE COMPANY WITH CAPABILITY FOR PROVIDING THE MOST ADVANCED, EFFECTIVE, AND ECONOMICAL SERVICES AND PRODUCTS AVAILABLE. THIS IS SUBSTANTIATED BY ITS RECORD OF PAST ACCOMPLISHMENTS...

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS
WASHINGTON 25, D. C.

August 6, 1962



FEDERAL AVIATION AGENCY
RESEARCH & DEVELOPMENT
COMMERCIAL AIRCRAFT DIVISION
WASHINGTON, D. C.

October 2, 1961

Lab 100, Room
15 Havens Street
Elmsford, New York

Dear Sirs:

With reference to Contract NAS-100-100, Re: U. S. B. S.
Air Traffic Control Systems Program, to be completed
by 1965, the Bureau of Standards is pleased to advise you that

UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
WASHINGTON
September 13, 1962

Mr. Sam G. Cohen
President
ESS GEE, INC.
15 Havens Street
Elmsford, New York

UNITED STATES DEPARTMENT OF COMMERCE
WEATHER BUREAU
WASHINGTON
September 13, 1962

Dear Sirs:

As you know, the National Bureau of Standards is cooperating with us by a contractual order of the design and development of our satellite data processing system. To date the former review has covered your plan for data communications from the Fairbanks remote station to the Weather Bureau Satellite Center at Suitland, Maryland, and for terminal processing of the data at the Center.

You will be interested to hear that the Bureau has concluded that your engineering approach appears to be based on good practice and should prove to be appropriate to project requirements, and that it generally follows a conservative pattern with reasonable latitude for contingencies. In summary, the Bureau concluded that "the data communications and terminal buffering proposed for the Nimbus program appear to have been well planned and should prove to be generally satisfactory."

Sincerely,

WESTERN UNION
TELEGRAM

SYNOPSIS: 48615

A MESSAGE IN ENGLISH FLD 5m
ESS-GEE INC.

15 HAVENS ST ELMSFORD NY

CONGRATULATIONS ON ACHIEVING RECORD OF LESS THAN TWO
ERRORS PER MILLION CHARACTERS. WE AGREED TO SHIPPING
SYSTEM TO MIAMI IMMEDIATELY.

ORNL BEHE U S WEATHER BUREAU

RECEIVED BY
FEB 13 1961
S. G. COHEN

ESS GEE inc.



15 HAVENS ST. ELMSFORD, NEW YORK

(914) LYRIC 2-8620

The U. S. WEATHER BUREAU, in February of 1961 congratulated ESS GEE on the specification-exceeding performance of a sensing and digitizing system which ESS GEE had designed, fabricated, and installed in three Meteorological Research Aircraft for the National Hurricane Research Program. To date, these systems have been performing with negligible downtime, with minimum troubleshooting, and with an extremely high reliability record of useful data.

The NATIONAL BUREAU OF STANDARDS concluded a formal review of ESS GEE's design and development study for the NIMBUS Satellite Data Processing System with the statement that the "engineering approach appears to be based on good practice and should prove to be appropriate to project requirements, and that it generally follows a conservative pattern with reasonable latitude for contingencies".

A major factor in ESS GEE's growth is the increasing amount of repeat business from satisfied customers...

In April of 1962, ESS GEE was awarded the U. S. WEATHER BUREAU prime contract for the design and fabrication of the above data processing system, which is to be installed in the National Meteorological Center at Suitland, Maryland... Following the successful completion of a logic equipment design and construction contract for the FEDERAL AVIATION AGENCY in the fall of 1960, ESS GEE was awarded an FAA contract for engineering consultation and technical services in support of the Air Traffic Data Processing Center at NAFEC. Since that time, repeat service contracts of increasing scope have been received, as well as a major contract for the improvement of design and extension of capability of an existing data processing system.

In evidence of its growth...

ESS GEE's sales volume for the past year has more than doubled from that of the previous year and its staff has grown over 50% in size.

Through highly selective staffing and the application of sound management policies, ESS GEE has succeeded in establishing and maintaining a closely coordinated and smoothly functioning organization. This is an organization well founded on individual and collective experience and background. On this foundation, and by encouraging and recognizing individual initiative, it fosters unlimited capabilities and potential for the future.

For more information
write to:
ESS GEE, INC.
15 HAVENS ST.
ELMSFORD, N.Y. 10523

Sincerely,
Sam G. Cohen
Contracting Officer

ESS GEE, Inc.
White Plains, N.Y.

CH

COMPANY HISTORY

ESS GEE was incorporated in the State of New York on December 1, 1959, and was in full operation on its own facilities by July of 1960. In the succeeding years, the company has experienced continued growth from a staff of 8 to one of almost 80 employees. Paralleling this, it evolved large increases in facility, equipment, and capabilities.

The summary of major contracts awarded ESS GEE, Inc, as shown on the following pages, gives evidence of cause for its rapid growth.

ESS GEE, Inc.
White Plains, N.Y.

CO

PROJECT OPERATIONS

Since its organization, ESS GEE, Inc, has grown from the original eight employees to almost eighty. ESS GEE's growth has exhibited rapid progress while building an organization to accommodate its means rather than its dreams.

It is the philosophy at ESS GEE that organization yields to the individual and that each person be given the opportunity to demonstrate his ability to perform both scientifically and administratively. At ESS GEE, each project engineer is charged with full project responsibility. It is his task to direct all functions necessary to bring about the successful completion of that project. The project engineer is responsible for preliminary study, project acceptance tests and delivery, and financial return.

ESS GEE achieves a unity of engineering effort along horizontal lines that utilizes the best each individual project group has to contribute. Such a horizontal engineering organization enables the customer to deal directly with the one person who has total project responsibility. This serves to eliminate the non-productive layers of red tape which delay engineering development and boost project costs. Each project engineer is acquainted with PERT, PEP, and Line of Balance, and uses them readily when project size or financial limitations require. ESS GEE's Project Review Board, which is composed of the Project Engineer and the Specialist Staff, acts in consonance with the Project Group. Meeting weekly, or more often if necessary, the Project Review Board ferrets out problems and solves them before they retard progress and increase project costs.

In total, horizontal organizational structure along with specialist review provides ESS GEE with an effective and consistent means of dealing with contingencies arising from complex engineering development. Such an operational mode, combined with strict adherence to financial controls, affords ESS GEE's project engineers the opportunity to continue a perfect record . . . a record of meeting both the financial and delivery milestones of more than 20 prime contracts with federal agencies.

ESS GEE, Inc.
White Plains, N. Y.

DC-1
March 1964

DESIGN AND DEVELOPMENT CONTRACTS

Customer and Contract

Program

Hurricane Research
Facility - USWB
Cwb-9930

Redesign and modification of air-
borne meteorological recording
systems.

Hurricane Research
Facility - USWB
Cwb-9946

Design and development of three
airborne systems to telemeter,
digitally quantize, and store on
tape meteorological data.

Federal Aviation Agency
FAA/BRD-265

Design and development of a digital
buffer system to link air traffic
control central computer and flight
data readout facilities.

Hurricane Research
Facility - USWB
Cwb-10082

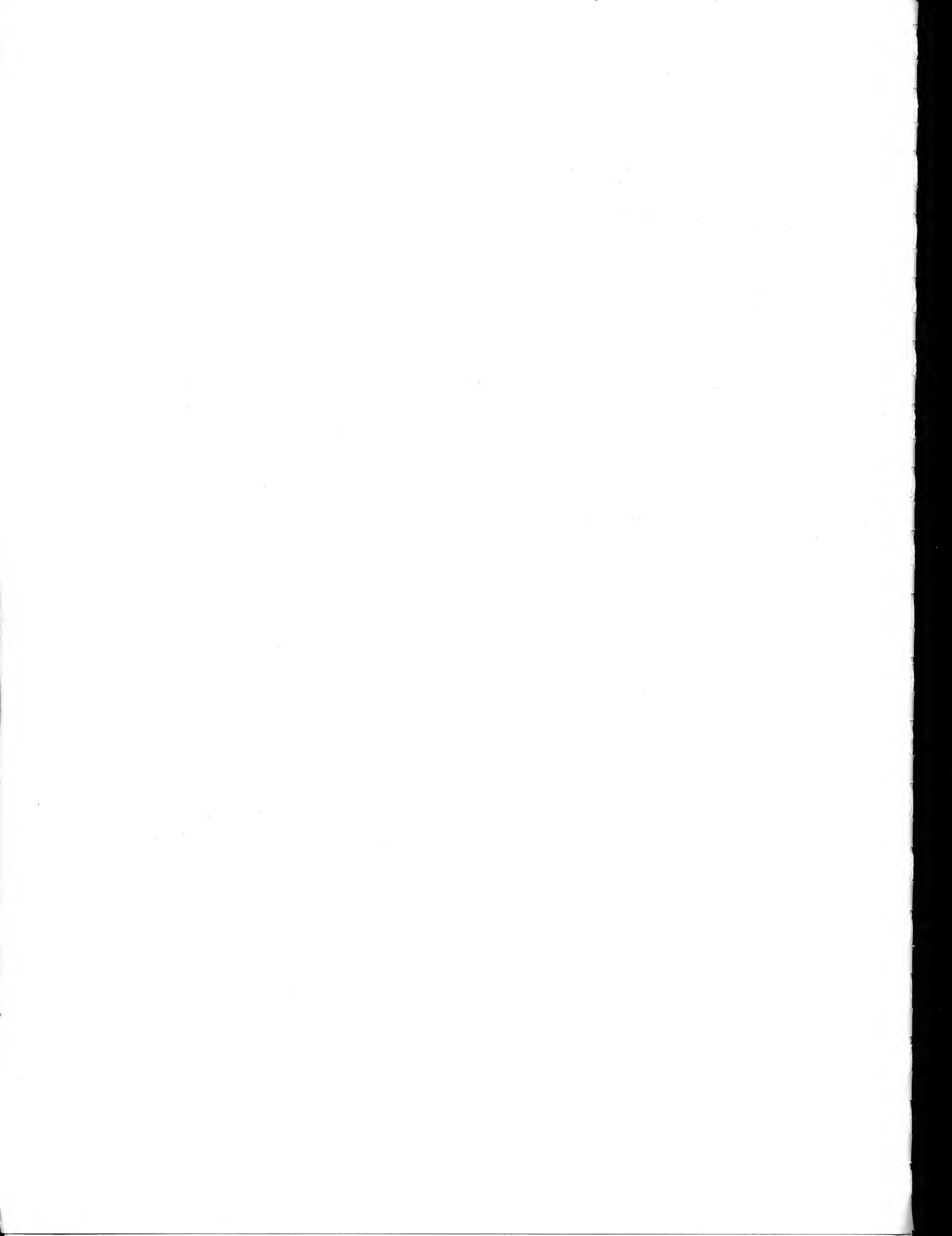
Design and development of three
airborne instrumentation systems
to sense and telemeter vertical
and horizontal wind gust veloci-
ties.

Hurricane Research
Facility - USWB
Cwb-10262

Design and development of two air-
borne meteorological telemetry
systems employing KDB-1 drone
aircraft.

National Weather Satellite
Center - USWB
Cwb-10334

Design and development of a
telemetry data acquisition and
processing ground station for the
NIMBUS Satellite (22 racks).



ESS GEE, Inc.
White Plains, N. Y.

DC-2
March 1964

DESIGN AND DEVELOPMENT CONTRACTS (CONT)

Customer and Contract

Program

Hercules Powder Corporation
11891

Design and development of a test facility for the igniter assembly of the 3rd stage of the MINUTEMAN Missile.

U. S. Naval Underwater
Sound Laboratory
N-70024-914

Design and implementation of improvements to a digital data recording system for use on-board an atomic submarine.

University of Wisconsin
BD-37301

Design and development of three all-weather digital data logging systems for recording data from meteorological sensors.

Hurricane Research
Facility - USWB
Cwb-10612

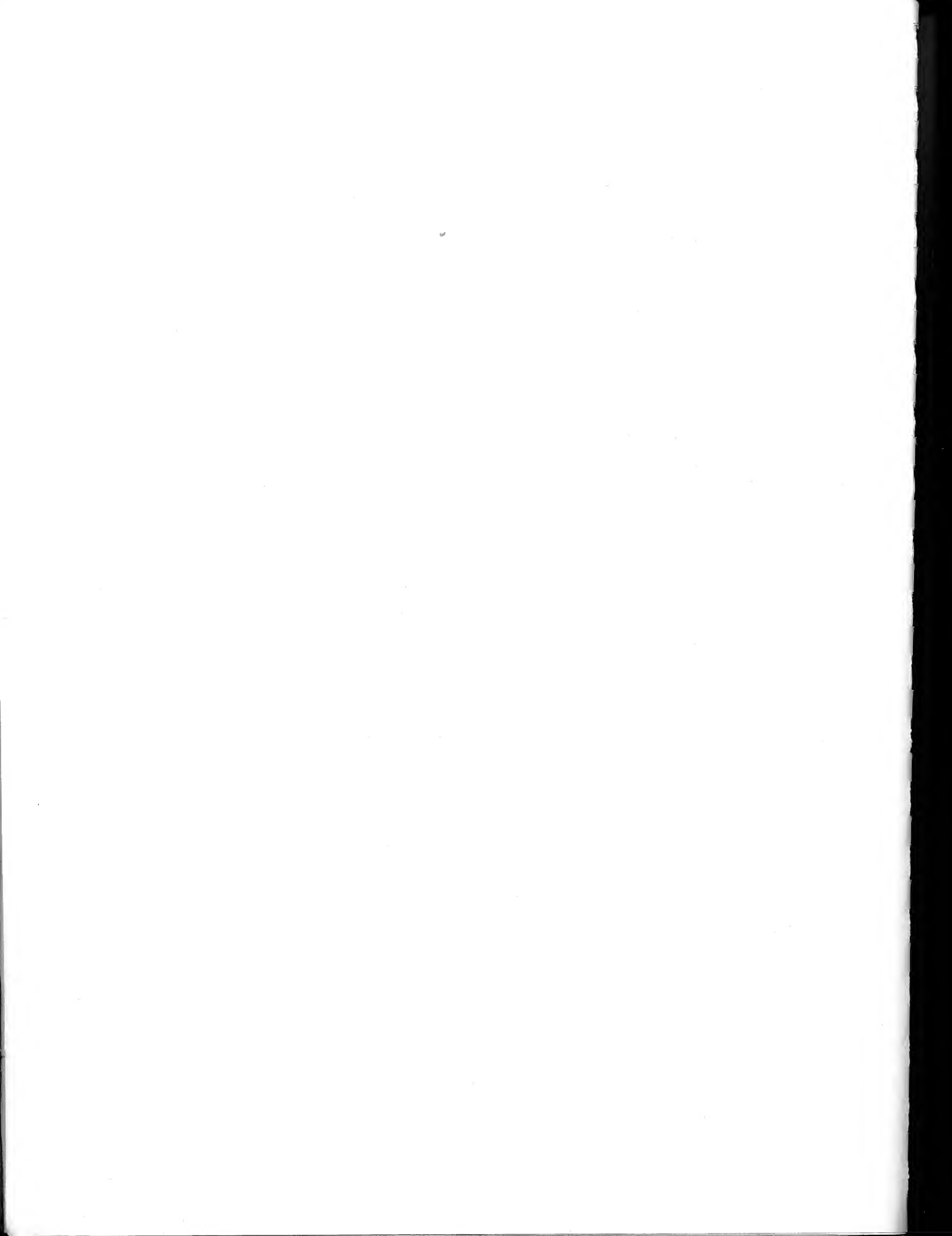
Design and implementation of an airborne meteorological instrumentation system for use on-board an F11F Mach 1.5 aircraft.

National Weather Satellite
Center - USWB
Cwb-10334

Design and development of video and infrared pattern generators.

Grumman Aircraft and
Engineering Corporation
2-67238

Design and development of two ground-based systems to multiplex, digitally quantize, computer format, and digitally tape record analog computer data for the Lunar Excursion Module used in the Apollo Program.



ESS GEE, Inc.
White Plains, N. Y.

DC-3
March 1964

DESIGN AND DEVELOPMENT CONTRACTS (CONT)

Customer and Contract

Program

Barnes Engineering Company
B-77553

Design and development of a high altitude airborne controller for four infrared camers (two ballistic and two spectral).

Naval Ordnance Laboratory
N-60921-8109

Design and development of a digital time clock to produce WWV time code in BCD format.

Woods Hole Oceanographic
Office
1824

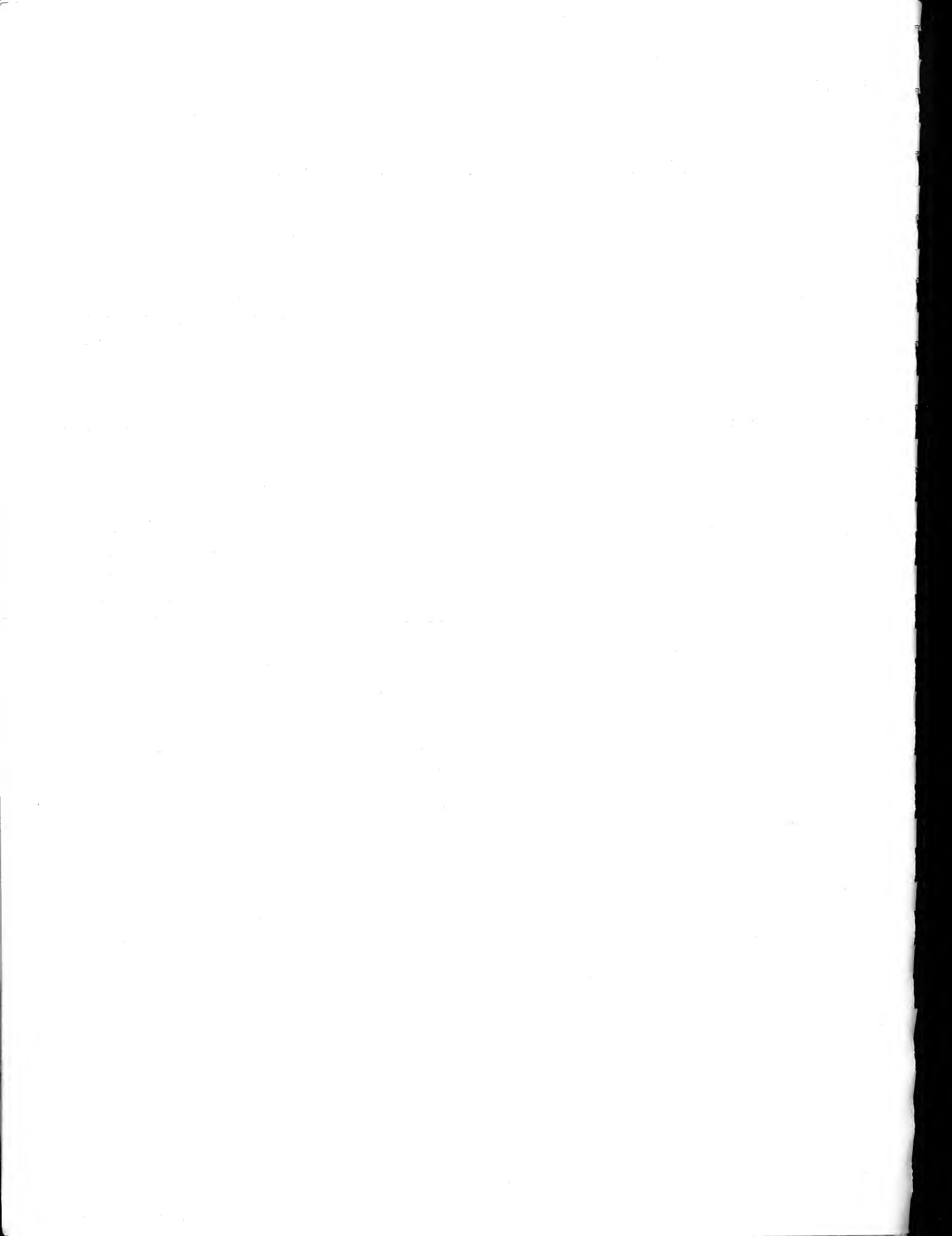
Design and development of a system to read two-channel grey-coded data from motion picture film exposed underwater and to convert the data first to pure binary and then to analog form for display on an oscillograph recorder.

Northampton Veterans Hospital
1874

Design and development of a low speed medical data acquisition system which multiplexes, digitally quantizes, and formats data for entry on to IBM punch cards.

Hughes-Simonson, Inc.
3243

Design and development of an instrumentation data acquisition and processing system for a 50-Megawatt Electro-Gas Dynamics Wind Tunnel for test of re-entry vehicles (47 racks).

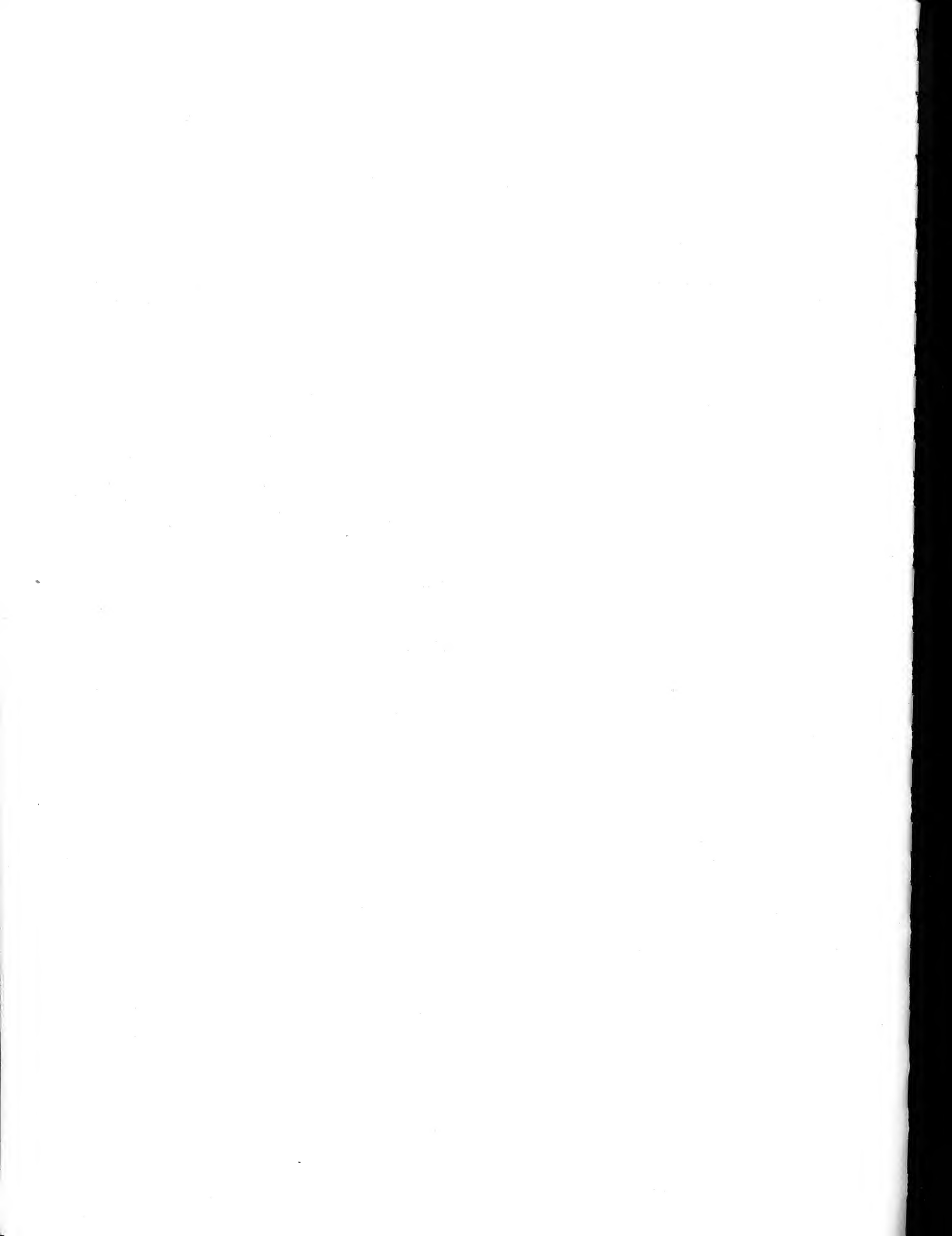


ESS GEE, Inc.
White Plains, N. Y.

SC-1
March 1964

STUDY CONTRACTS

<u>Customer and Contract</u>	<u>Program</u>
Federal Aviation Agency FAA/BRD-333	Study of data and equipment integration problems related to the interfaces of various air traffic control data processing subsystems.
Meteorological Satellite Laboratory - USWB Cwb - 10253	Design study to formulate requirements for telemetry of various environmental, electrical and angular position parameters of an infrared spectrophotometer and for multiplexing and digitally quantizing said data.
Norden Division - UAC 9356-N	Feasibility study of methods of signal conditioning and digitally quantizing the output of a MICROGON transducer
National Weather Satellite Center - USWB Cwb-10264	Study of problems related to real time processing of video, IR and monitoring telemetry data, gathered by NIMBUS Satellite and transmitted to earth, and formulation of design criteria.
Meteorological Satellite Laboratory - USWB Cwb-10495	Study of meteorological satellite sensor circuitry including tolerance and performance analyses, to verify achievement of design goals.
National Weather Satellite Center - USWB Cwb-10668-T2	Study of problems related to real time processing of video and auxiliary data, gathered by the IOMS Satellite and transmitted to earth, and formulation of design criteria.



ESS GEE, Inc.
White Plains, N. Y.

SC-2'
March, 1964

STUDY CONTRACTS (CONT)

Customer and Contract

Program

National Weather Satellite
Center - USWB
Cwb-10668-T3

Feasibility study for the develop-
ment of a system to enable direct
transmission of raw analog video
over standard facsimile circuits
without optical scanning.

American Computer Company
0102

Design study of an ultra low cost,
commercial, fixed program digital
computer.

ESS GEE, Inc.
White Plains, N.Y.

PLANT LAYOUT

Research and Engineering - the present area utilized totals 8,000 square feet. This area provides engineering offices, development laboratory, design and drafting space, and reproduction facilities. The area has complete electrical wiring and bench facilities specifically laid out for efficient development effort. Full test equipment is provided within the area. The test equipment is maintained by a preventive maintenance program which includes periodic calibration by ESS GEE's Quality Assurance Department. All test equipment is owned by the Company. ESS GEE leases IBM data processing equipment for most modern wire listing methods.

Assembly and Machine Shop - complete electronic fabrication and assembly facilities are available within a 9,000 square-foot area. This provides adequate facilities for simultaneous construction of complete data processing and telemetry ground station and airborne systems. Equipment is maintained for providing complete sheet metal fabrication and mechanical assembly. Electronic assembly bench areas, with individual power and illumination, provide for quality assembly of all types of electronic equipment. Supporting departments are wire cutting, harness fabrication, and printed circuit card assembly.

Quality Assurance - The Quality Assurance function, comprising Receiving Inspection, In-process Inspection, Final Inspection, Quality Control and Test and Evaluation, presently occupies approximately 500 square feet. This area is principally devoted to the final assembly test and evaluation. This section is supported by many specially-designed pieces of test equipment performing specific test functions for specific products. Adequate facilities are available for temperature and vibration evaluation tests for airborne units. A sub-group of this department maintains and calibrates all Company test equipment. Adequate secondary standards are maintained by this section to assure accurate calibration. The testing of all products is performed in a manner which contributes significantly to the reliability program.

General Offices and Services - The Marketing Division, the general corporate offices and the support functions, such as Personnel, Purchasing, and Accounting, occupy office areas totaling 3,000 square feet. All office facilities are fully equipped with Company owned equipment. Office space and secretarial services can be made available for customer representatives.

ESS GEE, Inc.
White Plains, N.Y.

COMPANY LOCATION AND FACILITIES

ESS GEE's principle offices, including engineering and production facilities, are located in White Plains, New York, in a well-equipped, modern air-conditioned building adapted to the specialized requirements of providing high-quality electronic systems for Government and industry.

The Corporation presently leases approximately 20,000 square feet and has at its disposal an additional 9,000 square feet into which it can expand within 30 days. The presently utilized space is supplied by adequate primary source of power for its fully equipped research, manufacturing, and office facilities. The most modern methods of lighting and heating are employed throughout the building which also includes facilities for employee relaxation. The facilities are supplied with an internal dial telephone system and long-line tie lines.

The plant is adjacent to major Federal interstate highways, is located minutes from a major railroad station, and is central to all major air-transportation facilities serving the greater New York metropolitan industrial center. ESS GEE's location in Westchester County is conducive to high company morale, offering excellent housing and recreational facilities. Because of ESS GEE's excellent employee-management relationship, this Company has had no time lost due to labor disputes since its origination in 1959.

All equipment now in use is owned or leased by the Company. No Government facilities are presently in use other than GFE which is deliverable with a contracted system. Arrangement can be made for employment of Government furnished equipment if this is deemed to be within the best interests of the program.

ESS GEE, Inc.
White Plains, N. Y.

TP2

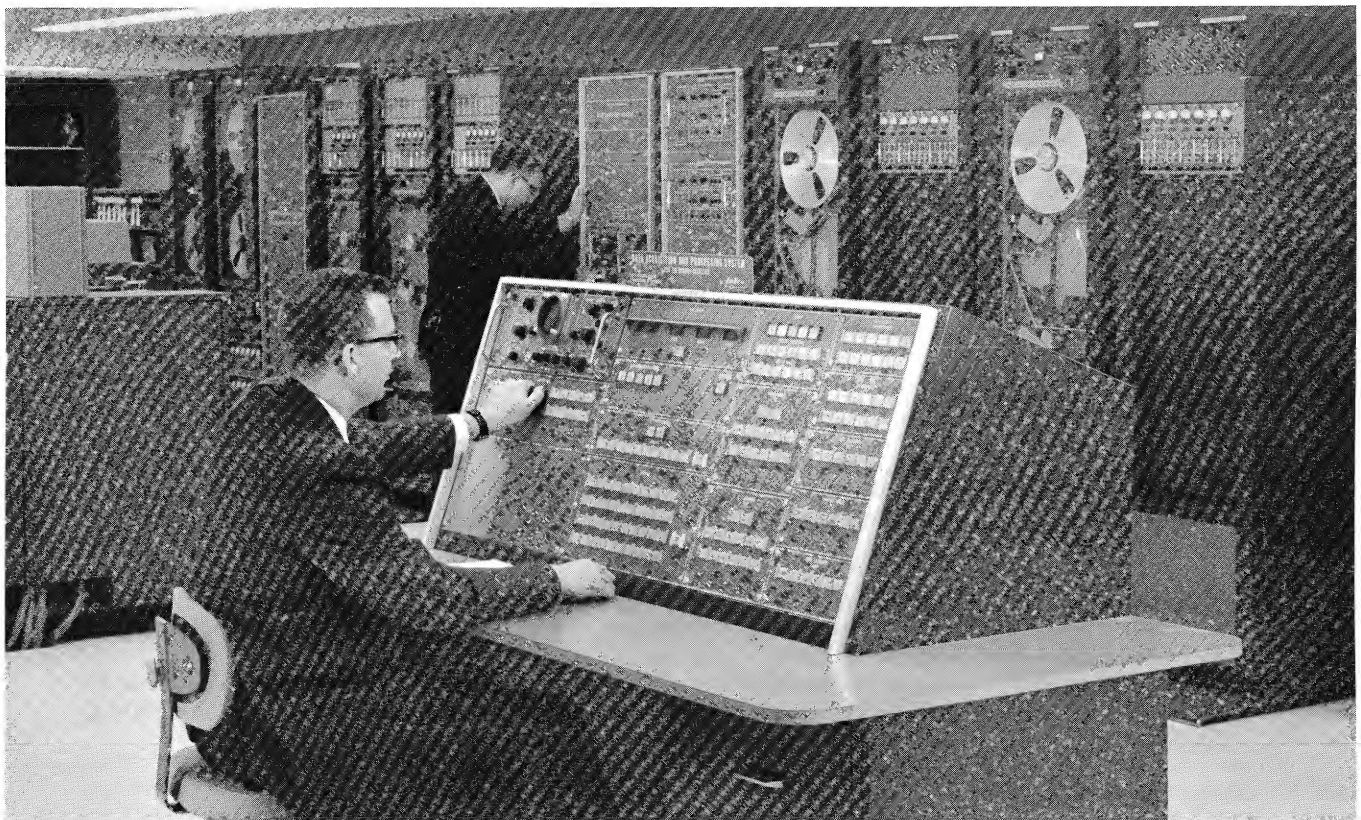
MAJOR PROJECTS
AND
FIELDS OF INTEREST



Bulletin

NIDAP

DATA ACQUISITION AND PROCESSING SYSTEM
FOR
THE NIMBUS METEOROLOGICAL SATELLITE



This paper was prepared by ESS GEE Senior Staff Engineer Alan Wachtel, presented at the National Telemetry Conference in Albuquerque, New Mexico in May 1963, and appears in the Proceedings of that conference.

DATA ACQUISITION AND PROCESSING SYSTEM
FOR
THE NIMBUS METEOROLOGICAL SATELLITE

Alan Wachtel
ESS GEE, Inc.

SUMMARY

This paper deals with a new data processing system, now under test, conceived for the National Satellite Weather Center of the United States Weather Bureau by ESS GEE, Inc.

The system is designed to accept a wide variety of inputs — including FM, PCM-AM, PDM-AM, serial and parallel digital data — and performs two major functions. The primary function is to format the input data for entry into a computer complex and the secondary task is to provide a means of displaying portions of the data in requisite format.

Flexibility and modularity is emphasized in the system design so that expanded requirements for the processing of additional data can be met readily with only the incorporation of the appropriate signal conditioners. Internal analog data speed buffering and high speed processing are provided so that data received at a wide range of rates can be readily accommodated.

INTRODUCTION

The NIMBUS Meteorological Satellite is being developed as the successor to the enormously successful series of TIROS Satellites. The TIROS series has yielded meteorological data which has unlocked the door to an era of greatly improved weather analysis. The advent of NIMBUS will throw open this door as complete global coverage offered by this satellite will enable the accomplishment of the above aim.

The implementation of a system to process the data from NIMBUS presented a host of problems to the designer. A long series of NIMBUS satellites is projected for launch during the next few years. As the series progresses satellite instrumentation will most assuredly change radically as equipment refinements are made and improved second and third generation sensors become available. This then demanded a system design which allowed for change and expansion with a minimum of alteration to the original system.

SYSTEM BACKGROUND

The system designed was primarily influenced by the satellite sensory sub-systems and the end products desired therefrom.

The sensory sub-systems whose outputs are to be processed by this system are divided into four groups:

Television

A three vidicon camera system whose wide angle and overlapping pictures of daytime cloud cover yield complete and overlapping coverage from one orbit to the next, synchronized to the retrograde orbital motion of the satellite with respect to the earth. Thirty-three triplets of pictures are taken per orbit.

The satellite output is received by the system in FM form on three separate unmultiplexed channels (one per camera). The 833-line resolution of the vidicon and the 16-increment gray scale resolution of the phosphor results in a total amount of data per orbit, in digital form, for the three-camera system, of approximately 69 million 4-bit resolvable spot samples.

High Resolution Infrared Radiometer (HRIR)

This subsystem is designed to provide cloud-cover data during the dark portion of the orbit, at which time the television sub-system lacks the sensitivity to provide good pictures by star illumination. The sub-system utilizes an energy integrating detector, 1% resolution, which scans the earth from horizon, the sky, the satellite housing, the sky and then the earth again by means of a rotating mirror system. The scanning rate is such that in one mirror period the satellite advances along its orbit a distance equal to the resolvable width of the area scanned by one rotation of the mirror system. This will result in the production of a nighttime complement to the vidicon produced daytime cloud-cover pictures as a result of the differences in target energy imaged from land, sea, ice and varying thicknesses of cloud-cover.

The satellite output is received by the system in FM form and converted to digital form totals in excess of 2 million 7-bit characters per orbit.

Medium Resolution Infrared Radiometer (MRIR)

A five channel energy integrating detector, 1% resolution, designed to yield data on reflected solar and terrestrial radiation. Each of the five channels monitors a different energy wave length producing data on the following:

- a. Thermal radiation
- b. Reflected solar radiation
- c. Water vapor absorption
- d. Cloud to earth contrast reference
- e. Heat balance of the earth

The satellite output is received by the system in FM multiplex form and after conversion to digital form totals in excess of 500,000 7-bit characters per orbit.

PCM Telemetry

A telemetering system to monitor spacecraft performance during its useful life. In excess of 540 points are monitored, each to an accuracy of 7-bits, yielding information useful not only for spacecraft monitoring but also for rectification, correction and calibration of the data. The stored telemetry data are recorded on tape during a complete orbit and are played back upon command by the ground station. The data are received by this system in PCM-AM form and totals almost 400,000 7-bit words per orbit.

Obviously the satellite output data from the four above sub-systems must be related to geography to be of any use. Orbital determination and absolute time are, therefore very important. To provide the latter, the satellite's crystal controlled master timing system is utilized. The crystal frequency is divided to a number of lower frequencies. Two of these are used as absolute frequency references for the television and high resolution infrared sub-systems. Each frequency is amplitude modulated with a satellite computer-generated standard NASA-36 bit time code. This code uses 4-bit BCD characters to encode seconds, tens of seconds, minutes, tens of minutes, hours, tens of hours, days, tens of days, and hundreds of days. It logically employs pulse width modulation to define "ones" and "zeroes". The satellite output is then a PDM-AM time code reference and is transmitted both with the television data and the high resolution infrared data.

SYSTEM REQUIREMENTS

The system was designed to meet the following requirements:

1. On-line processing of data routed over a 6,000 mile transmission link from an Alaska ground station. The elapsed time between orbital transmissions of data to earth will be either 103 minutes (500 mile orbit) or 108 minutes (600 mile orbit). Transmission time between the Alaska ground station and the National Satellite Weather Center data processing facility is irreducible below a 41 minute minimum because of transmission line bandwidth limitations. Facility must be provided to accommodate double orbit playbacks from the satellite for the four daily orbits where the satellite does not come within acquisition range of the ground station. A double orbit playback implies an approximate 84 minutes of data transmission. This must all be received, formatted, and processed before the next pass occurs, possibly only 19 minutes later.
2. Simultaneous processing of at least five channels of Non-IRIG FM data. Three channel parallel video data is received during one time interval, five channel multiplexed Medium Resolution Infrared data and single channel High Resolution Infrared data during other intervals.
3. Analog multiplexing capability for at least five channels of data at megacycle rates. Both the Video and Medium Resolution Infrared data must be multiplexed to allow analog-to-digital conversion by a single converter.
4. A maximum analog-to-digital converter sample rate, of 1 million samples per second.
5. Flexibility of sampling accuracy enabling selection of both 4 and 7 bit accuracies, 4 bits for the video data and 7 bits for all infrared data.
6. Processing of two channels of PDM NASA-36 bit time code data received from the satellite.
7. A capacity for serial-to-parallel conversion of PCM data.
8. An input PCM rate with a minimum of 15,000 samples per second.
9. Complete control of digital output format — including variable word and record lengths with facility for injecting queuing marker bits into the format.
10. On-line film reproduction of video data for quick look analysis. A film format is required that has the three parallel outputs — left, center and right — from the satellite vidicons sequenced in that order — frame by frame — on single film strips — 70 mm for quick-look analysis and 35 mm for archival storage.
11. Automatic on-line superposition of latitudinal and longitudinal grid coordinates and alpha-numeric indexing data on each video picture reproduced on film.
12. Digital Computer program control of the system's basic modes of operation — start, stop and sequence — so as to synchronize computer processing with the system's acquisition, conversion, and formatting functions.
13. Fidelity of data reproduction as compared to original form as generated in the satellite. The effects of satellite and ground station tape recorder flutter and wow to be

minimized by compensation techniques incorporating both amplitude and frequency correction features.

SYSTEM CONFIGURATION

The NIMBUS Data Acquisition and Processing System is mounted in instrument type standard 19-inch equipment racks.

Some of the features of interest on the specific system components are presented below.

Control Central (Figure 1)

The Control Central performs data-management tasks which must be accomplished at prescribed times. Its prime function is to establish the system's mode of operation for each type of data received. Some of the tasks involved include:

1. Provision of mode commands to the Switching System so as to interconnect the various sub-systems into data channels.
2. Provision of basic controlling functions to the signal conditioning sub-systems.
3. Remote automated control of the system's monitoring and bin storage tape recorders.
4. Control of test modes to enable individual sub-system test, channel test, or system test. Includes selection of signal simulation and test pattern equipment as inputs to various portions of each data channel.
5. Transmission of alerts and alarms.

The Control Central will primarily be directed by the executive program of the system's main data processor. This is done in order to maintain systematic and efficient operation of the system undisturbed or delayed by human factors. If processing requirements of the data are altered, the executive routine can be modified to handle the change without engendering new equipment costs.

The system will have a Control Console which will serve as a monitoring point for system operation, as a means of directing test modes of operation, as a standby control center for limited processing functions should the executive computer suffer unscheduled downtime, and as a means of switching in standby sub-systems to replace malfunctioning units.

System Switching (Figures 2, 3, and 4)

Three racks of the system are used to house relay switching.

The purpose of this equipment is to provide a flexible interface between the transmission line terminal equipment, the video picture reproduction equipment,

the digital encoding equipment, the intermediate conversion and conditioning equipment, and the various system tape recorders. All switching operations are directed by the system's Control Central.

Input Signal Switching enables the transfer of data from the transmission line terminal equipment to the system's intermediate buffering tape recorders and the transfer of priority data, received in real time as the satellite plays back to the ground station (e.g. PCM monitoring telemetry), to associated conversion equipment. It also enables the playback of the system's transmission line monitoring recorders to the system inputs.

Tape Recorder Switching is provided to feed the outputs of the system's tape recorders to the appropriate signal conditioning and conversion equipment. The outputs of the tape bin recorders are routed so that the video (3 channel), high resolution infrared, and medium resolution infrared (5 channel) analog data are fed to their appropriate discriminators. Similarly, the tape bin recorders' video and high resolution infrared time reference data outputs are routed to PDM Time Code Converters and those same signals plus the medium resolution infrared reference frequency are fed to Tape Speed Compensation discriminators.

Output Signal Switching is provided to channel the outputs of the PCM and PDM converters to the direct digital input channels of the system's Format Control Unit. It is also provided to route, at the appropriate time, the analog outputs of the data discriminators to the system's high speed multiplexer which feeds a high speed analog-to-digital converter whose digitally encoded output is then in turn fed into the Format Control Unit.

Monitoring Tape Recorders

Two reel-to-reel wide band (300 KC) instrumentation tape recorders are utilized to monitor the transmission line terminal equipment during the course of a transmission from the ground data acquisition station in Alaska. This provides a record of the raw data, thereby enabling a replay of the transmitted information should an equipment failure occur in the system or information be erroneously destroyed. These recorders have the facility of playing back to the system inputs thereby simulating a transmission line input.

Bin Storage Tape Recorders

On-line processing is an operation abhorrent to most commercial computers, the ones utilized in this system are no exceptions. On-line processing signifies, in the worst case, a mode of operation where the computer must accept data from a source (i.e. transmission line) whose output is continuous or in blocks infinite in duration insofar as a computer's core memory is concerned.

Analysis of the video data being received indicated a reception time of greater than 30 minutes. If the processing computer were directly coupled to the data

source through translation networks, the processing program would be severely hampered. This results from the fact that the computer would have to remain on-line almost continuously in an input routine that permitted no interruptions to the flow of data. If operations are to be carried out in the computer's central processor or in other data channels, this would be an impossible condition to maintain. The computer is then slaved to the input channel operation and its processing time is limited to the program cycles available between word ingestions.

The obvious solution to this problem would be to increase the speed of the data before entry to the computer. However, a problem exists. The delay engendered in tape recording the entire record, rewinding the tape, and playing it into the computer at a higher rate of speed is intolerable to the users of the data. True on-line processing is required.

To solve this problem a unique technique of speed buffering the analog data was developed. The input to the computer was accelerated during the data reception time without interrupting the reception of data from the transmission line by means of a bin storage tape recorder.

The technique instrumented for our system (See Figure 5) is one where the data is received over a long period of time at a relatively slow rate, and is written on tape that is drawn from a supply reel and passed over record heads by a synchronously driven record capstan and then deposited loosely in a storage bin. The other end of the tape passes through an exit opening in the bin, is passed over read heads and onto a takeup reel. However, tape is not drawn from the bin until a computer determined record length has been accumulated. When playback is commanded, the read capstan, not slaved to the record capstan but independently driven, extracts the tape at a higher rate of speed than the record speed in integral record lengths. The advantages of such a system are obvious. First, the recording process is an independent variable, unaffected by the rest of the system, and is continuous. The playback process, however, can be performed at a higher rate of speed in computer controlled bursts.

If the playback speed for computer input is N times the record speed, only $1/N$ of the total reception time is spent on computer input. For example: if the incoming data is recorded at 7.5 ips and played back at 60 ips, the computer is on-line for the input routine only $1/8$ of the time that it took for the data to be received by the system. This frees the computer for uninterrupted processing during the remaining $7/8$ of the time prior to the next playback command.

The end result is that the computer is tied to an input routine for only short periods of time and is free to process during a much longer period of time before being required to signal for the next playback. This buffering also provides flexibility to the system in that changes in transmission line transfer rates can be absorbed by this buffer, thereby preventing the quick obsolescence of the digitizing equipment between the

bin recorder and the computer.

The limitations to this scheme lie in the size of the bin, the speed range capability of the bin recorder and the ingestion rate capability of the computer. In the system under discussion the limiting element has proven to be the system's computers utilizing their fastest input channels.

Discriminators

Twelve phase-locked solid state discriminators are provided to convert the video and infrared data from FM back to analog form. Eleven of these are providing data to the digitizing sub-system and are compensated to remove the effects of tape recorder flutter and wow. The time code reference channels associated with the video and high resolution infrared data and the reference frequency channel of the medium resolution infrared multiplex all contain carrier frequencies derived from the satellite's master clock system. Any deviation in these frequencies is construed as a composite error resultant from tape speed deviations originating in satellite, ground station, and data processing center tape recorders. The effect of flutter and wow on the FM signal is two-fold. The deviation changes resulting in a signal amplitude error and the rate of change of deviation is altered resulting in a time-base error. Discrimination of the reference frequency associated with one or several data channels yields a DC error voltage. This is injected into the associated data discriminators to offset the discriminators' VCOs and will result in the removal of the lower order amplitude errors in the data.

Multiplexer

The multiplexer is a high-speed switching commutator consisting of a semiconductor switch for each input channel. The switches connect one input channel at a time to the system's analog-to-digital converter. The device is utilizing a maximum of five channels out of its present configuration of ten. The ten are expandable within the present chassis to a total of 24. The sequencing rate of this device is one million commutations per second at a maximum.

Analog-to-Digital Converter

The analog-to-digital converter employed utilizes a technique of parallel-feed-forward encoding of analog signals. In the conversion process, an individual comparator is used for each bit. Both the analog signal and the comparator outputs are stored, the former in delay lines and the latter in flip-flops, so that each succeeding bit comparator receives the results of all preceding comparisons. The device is composed of eight logical approximation converters yielding an encoding accuracy of 8-bits. Each succeeding converter has the capability of encoding one more bit than its predecessor and utilizes the outputs of all preceding converters in the process. The encoding rate utilized is one million samples per second. As an 8-bit unit it is capable of a maximum rate of 2.5 million samples per second and as a 7-bit

unit, 5 million samples per second.

Sample Rate Control

The sample pulses are provided to the analog-to-digital converter by a sample rate control system located in the Format Control Unit. The sample rates for each type of data are adjustable by patch board over a wide range of values.

In the previous discussion of discriminators, the effects of tape recorder flutter and wow are mentioned. Compensation at the discriminators resulted only in amplitude compensation of the data. The bin storage recorders employed, utilize a low mass servo system capable of compensation for time-base errors that occur at rates less than 10 cps. Here at the analog-to-digital converter remains the last opportunity to correct the higher order time-base errors.

To accomplish this the reference frequencies associated with the data are again employed. The sample pulse rate is phase-locked to the reference frequency so that any variation in the reference frequency that occurs within the acquisition range of the phase-locked loop will be translated into an increase or a decrease in the sampling rate, dependent on the direction of reference frequency deviation.

PCM Synchronizer and Serial-to-Parallel Converter

The synchronizer portion of this unit accepts noisy but bandwidth limited PCM-AM monitoring telemetry data (100% modulated) from the transmission line. Filtering to one-half the bit-rate, is accomplished by linear phase filtering techniques. The data from the filter is then peak detected (positive and negative peaks) to determine the median voltage level. This level will be utilized as a comparison reference level against the incoming signal. Determination of "ones" and "zeroes" will depend on whether the filtered input signal is below or above the reference. The output of the comparator is shaped and is fed out in serial digital NRZ form as the desired data.

The bit clock is implicit in the data and is recovered through the use of phase coherent techniques. The output of the comparator is phase shifted by 90° and then phase-locked to a voltage controlled oscillator whose center frequency is nominally the bit rate, 15 KC. When the phase comparator in the phase-locked loop adjusts the voltage controlled oscillator so that the output of the phase comparator is zero, then the voltage controlled oscillator is locked to and 90° out of phase with the other input to the phase comparator. This then means that this signal is back in phase with the source clock and that the clock and data transitions are coincident.

Both the clock and the NRZ data are fed to the serial-to-parallel converter. This device obtains frame synchronism, extracts the frame synch code, and outputs 7-bit parallel data words with an associated clock. Frame synchronism is obtained by use

of a parallel pattern detector and a sequential frame synch test circuit to verify synch once it is assumed to have been obtained. The verification makes allowances for the stochastic nature of the source so as to enable maintenance of synchronism in the presence of a high random error rate.

PDM Time Code Converter

The four units employed (in the system) are identical in nature with only input data rates and frequencies differing between the units.

Each unit accepts serial PDM-AM time code information whose code format is identical to that transmitted by WWV and converts it into serial digital NRZ data. The device is capable of time code conversion of data received in both the forward and backward directions, selectable by remote electronic or local manual control.

In the conversion process, frame synchronism is obtained on the exclusive one second reference codes and all of these codes are extracted from the serial wave train. In addition, all of the 6-bit intergroup gap characters separating the BCD time code characters are deleted from the wave train. A synchronous bit clock is developed from the data and it along with the data are transmitted in an intermittent series of pulses because of the above discussed deletions.

Format Control Unit (Figure 6)

The purpose of this unit is to provide a means whereby all of the dissimilar digital data received can be efficiently formatted for acceptance by the system's computers.

Data can be taken from the system's analog-to-digital converter in N-bit elements, N selectable by patch board for each operating mode, $2 \leq N \leq 8$. Selection of N also infers determination of the number of samples to be packed in the unit's 36-bit formatting registers, $36/N=M$ where M is an integer or rounded off to the lesser integer when fractions are present.

The three register packages associated with the analog-to-digital converter can have their inputs and outputs sequenced such that multiplexed digital characters can be demultiplexed in this unit. This operation is controlled by the mode logic.

As was discussed previously, the sample rate control provides the necessary clocking for the analog-to-digital converter and the correct sequencing for the multiplexer. Integral multiples and submultiples of each sampling frequency are utilized for data manipulations in the three register packages.

All four of the register assemblies are provided with switching circuitry to allow selection of either internal clocking or clocking provided with data by external equipment at a cable connector.

The fourth register assembly is utilized to format time code data received from the system's PDM Time Code Converters in serial form under the control of synchronous clock pulses received with the data. Provision has been made to allow selection of discrete time codes from a group so as to allow editing of redundant or unnecessary information.

All four of the register assemblies have the facility of entering marker or flag bits into predetermined register addresses, depending on the operating mode, which are to be used for queuing the computer program.

One of the important operational functions of the system is the reproduction of the video pictures as soon as possible after satellite readout. These pictures are to be reproduced under the following stipulations:

1. Latitudinal and longitudinal gridding is to be superimposed upon the pictures.
2. Alpha-numeric indexing is to be superimposed upon the pictures.
3. The parallel triplets from the left, center, and right camera sources are to be combined on one film strip in a left, center, and right serial sequence.
4. The pictures are to be reproduced on a display device whose operating speed is eight times faster than the rate of the data received from the transmission line.
5. Pictures to be reproduced on-line to the data transfer from the ground station.

These tasks are accomplished by four groups of equipment, (See Figure 7). The first calculates the gridding for each picture and produces gridding signals to be recorded with the video data on instrumentation tape. The second produces the digital alpha-numeric indexing data to be superimposed on the picture and performs a cross-correlation check on the time code data received with video data against the time codes associated with the gridding data, to ensure that the correct grid coordinate system is superimposed on each picture. The third, referred to as the tape loop buffer, receives the signals from the first and second groups and from the transmission line, serializes the three concurrent parallel frames and raises the data rate by a factor of eight. The fourth group of equipment referred to as the picture reproduction unit, generates the pictures with all associated data, records them on film, and processes the film to get either a positive or negative film strip.

Latitude and Longitude Grid Production

The first information to be received from the transmission line is the video time code reference data and the monitoring telemetry data. Both are transmitted directly from the ground station receiver during satellite interrogation time. The video data has a bandwidth

which requires taping of the data at the ground station and then replay at 1/8 speed to accommodate the data within the channel bandwidths of the transmission line. The time codes and the telemetry are routed directly into the system's main data processor. Orbital information from the world-wide Minitrack sites (i.e. ground track, latitude and longitude as a function of time) is supplied daily by NASA giving the predicted orbital locations of the satellite. This is entered into the computer.

The computer up-dates the predicted orbital data by the use of satellite attitude information in the monitoring telemetry data and determines the grid coordinate systems to be generated for each vidicon frame triplet based on the time code reference data received. The computer produces a digital tape containing the location of grid points for each horizontal scan line of each of the video pictures.

The digital tape is then played into the system's auxiliary data processor which performs the function of detecting the video horizontal synchronizing pulses and then of timing the points along each scan line which are to be gridded. The output grid pulses from the computer, synchronized to their appropriate video scan line locations, are separated into three channels, one for each of the three video channels. The three grid pulse channels and the three video channels with their associated reference frequency channel are routed to the tape loop buffer.

Character Generation and Grid Correlation

The same digital tape that brings the gridding information into the auxiliary data processor also contains indexing and picture time reference data.

The indexing information consisting of orbit number, frame number, camera number, shutter time, etc., is formatted and queued within the computer so that immediately upon completion of the gridding routine an alpha-numeric indexing output is initiated. The 6-bit parallel characters out of the computer are serially formatted in an input character control unit which sequences the indexing data in a manner similar to that done for the gridding data. The indexing data for a particular picture of a left, center, right triplet is placed on the same tracks of the instrumentation recorders utilized in the tape loop buffer as the gridding pulses for that picture. At the output of the tape loop buffer, the indexing data is converted back to parallel form and buffered in an output character control unit contained within the picture reproduction unit.

Grid correlation is a function performed to ensure that the gridding coordinate systems superimposed on pictures are not the wrong coordinate systems. This is accomplished in the following manner:

The time reference codes received initially with the monitoring telemetry data are the basis for the grid coordinate system for each picture triplet. Consequently, the digital tape bringing gridding data into the auxiliary computer also contains the original time reference code

associated with each picture triplet, tagged to the gridding data for that triplet. The grid routine is initiated by the start of video reception. Received in parallel with the video are the same reference codes which were received earlier. These time codes are converted into serial NRZ data by a PDM time code converter and formatted for entry into the auxiliary computer by a time entry unit. The computer correlates the newly received time code with the prestored one, received with the gridding data now being sent out. If the correlation is good the computer takes no action. However, if it is bad, then two actions transpire. One, since the correlation is not completed until in excess of 100 video scan lines of the triplet in question have been gridded, it is too late to stop the grid points from entering the tape loop buffer. Therefore, the auxiliary computer generates a "grid disable" signal and sends it directly to the grid signal generator within the picture reproduction unit to block incorrect grid production. Second, the auxiliary computer determines the location of the correct grid coordinate system for the next video triplet and requeues the gridding routine accordingly.

Tape Loop Buffer

This sub-system is comprised of three continuous loop tape recorders, two operational and one standby, and control and switching logic required to accomplish its assigned task.

The parallel video information as received from the transmission line is at a frequency which is 1/8 of that required by the picture reproduction unit. The incoming frequency can be accommodated on a wide band instrumentation recorder at a tape speed of 7.5 ips. The method of serializing and speeding up the data is as follows:

One loop recorder waits, on-line, for data. When the data is received, this machine records the video and gridding data inputs on parallel tracks. At the end of the first video triplet the data input is switched to the second loop recorder. While the second triplet is being recorded, the first recorder plays back the first triplet at a speed eight times faster than the record speed—60 ips. One complete revolution of the loop is required for each track of data plus one revolution to ensure complete erasure of the data by the erase head after playback. The speed ratio between playback and record to ensure completion before the next set of records is to be recorded on this machine must be:

$$\text{SPEED RATIO} = (N+1+F_a+F_d) R$$

where: N = the number of parallel data tracks to be serialized
 1 = extra revolution required for erasure
 F_a = factor determined by the accelerate time of the recorder
 F_d = factor determined by the decelerate time of the recorder
 R = ratio of loop length to record length

The tape recorders employed have rapid accelerate and decelerate times. Therefore, a parentheses term of $N+2$ provides an ample margin of safety. Since $N+2 = 5$ for this application and a speed-up ratio of 8 is used there is a wide margin of safety if R is less than 1.5.

The loop continues to cycle and a sequencing system switches the outputs from track set to track set as each of the records approaches the reproduce heads. At the conclusion of the playback operation, this recorder is now available for another record cycle and the second recorder awaits the command to playback. The total length of the tape loop is constrained to a length slightly larger than one record length so as to accommodate tape recorder acceleration and deceleration intervals.

Picture Reproduction Unit (See Figure 8)

The information at the output of the tape loop buffer consists of a single FM video channel, a gridding pulse channel, indexing information and the associated time code reference channel. Originating from the gridding control computer is another signal referred to as "grid disable".

The video data is discriminated to obtain an analog format. The horizontal synchronizing pulses are detected at this point and are used to trigger the horizontal deflection circuitry and the alternate vertical synchronizer (discussed below).

The analog video signal is routed through the gridding signal generator normally without change. Upon receiving a grid pulse from the appropriate track of the tape loop buffer, the gridding signal generator will compare the video level at that instant of time with a reference level. If the video is above the reference level indicating a shade of gray tending toward white, this unit's output will be clamped to a level corresponding to full black. Similarly, if the video is below the reference level indicating a shade of gray tending toward black then the output will be clamped to a level corresponding to full white. Should a "grid disable" be received as an output from a cross-correlation check in the gridding computer, all grid pulses will be ignored for the duration of the frame.

The output of this unit feeds a video amplifier and a gamma correction circuit (to correct for film and phosphor non-linearity) which in turn modulates the kinescope beam intensity.

Detection of the reference frequency by the vertical synchronizing detector provides a retrace trigger to the vertical deflection circuitry and a film advance signal to the controls of the camera and rapid film processor sub-system. Should the functioning of the vertical synchronizing detector be unreliable or incorrect because of waveforms, modulation, or absence of the time signal, the alternate vertical synchronizer can be switched on. It uses the first or second horizontal synch pulses of each frame on the video channel to trigger the vertical deflection and film advance circuits.

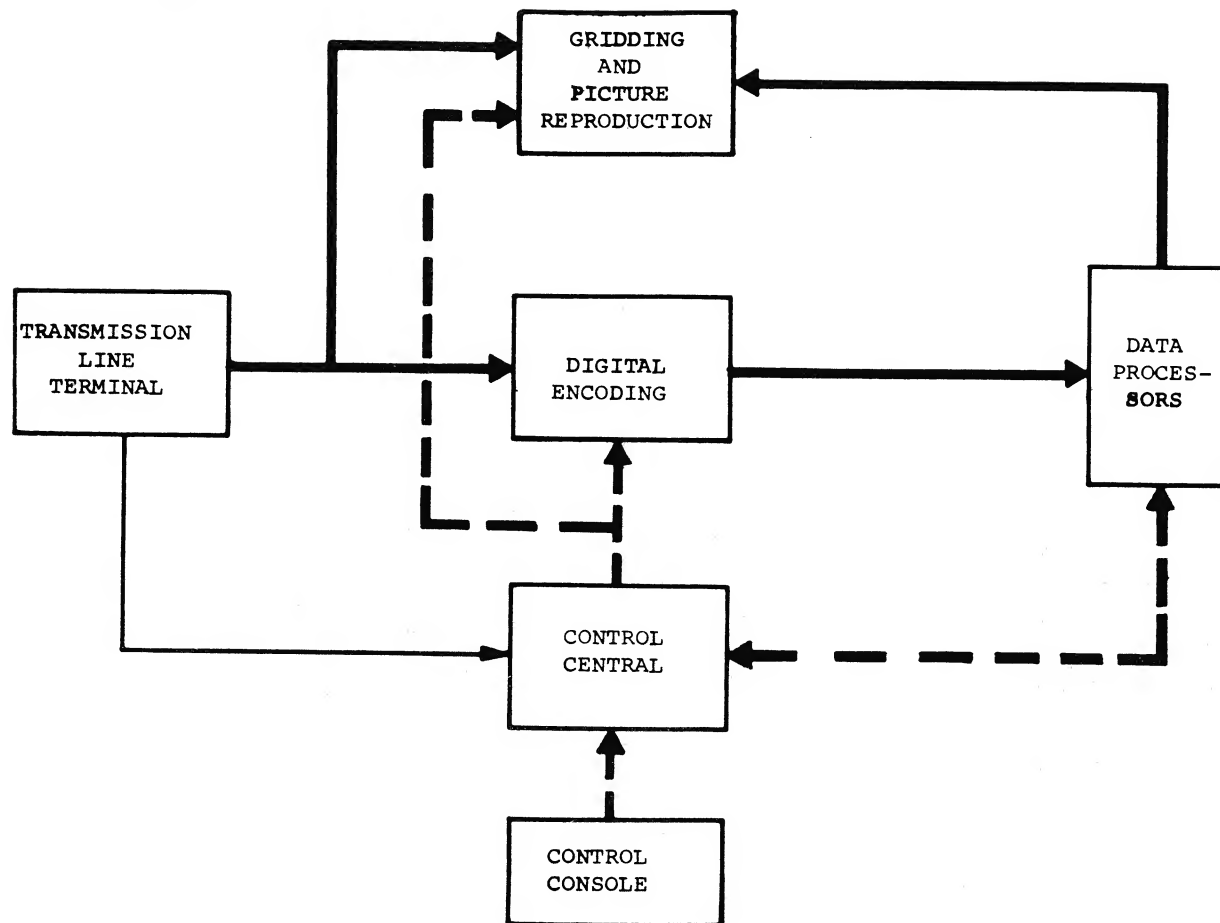


Figure 1. System Configuration

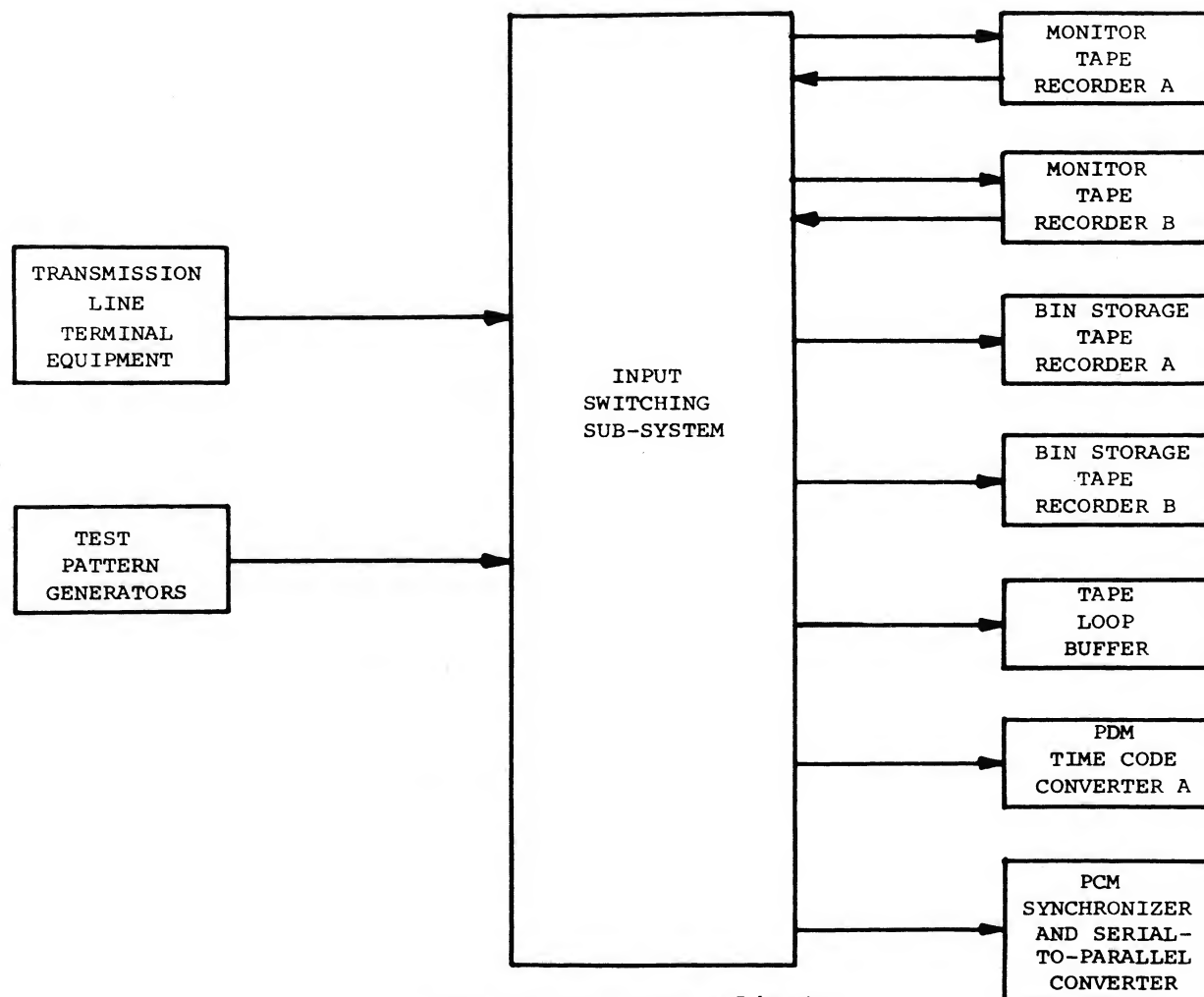


Figure 2. Input Processing Subsystem

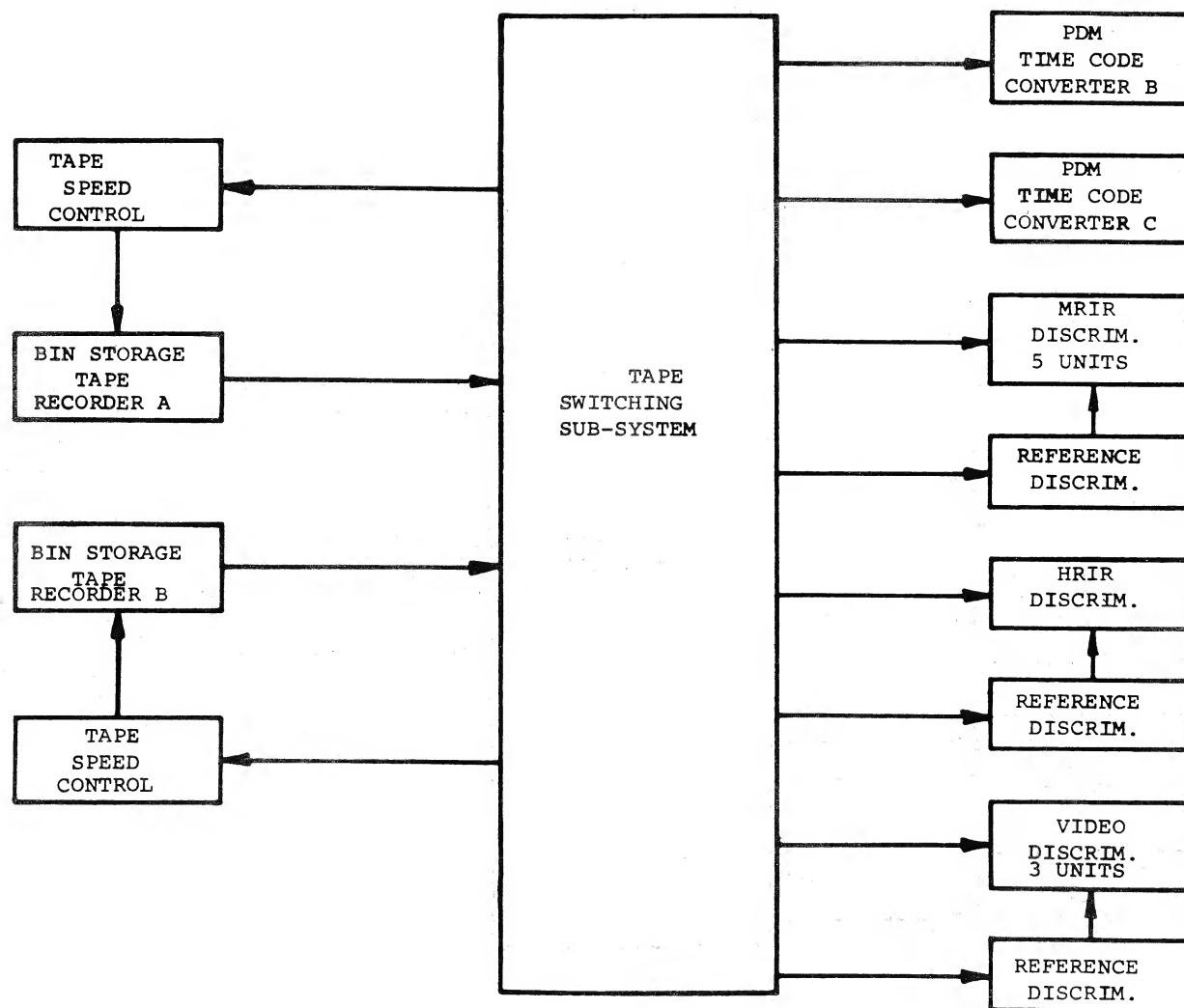


Figure 3. Tape Processing Subsystem

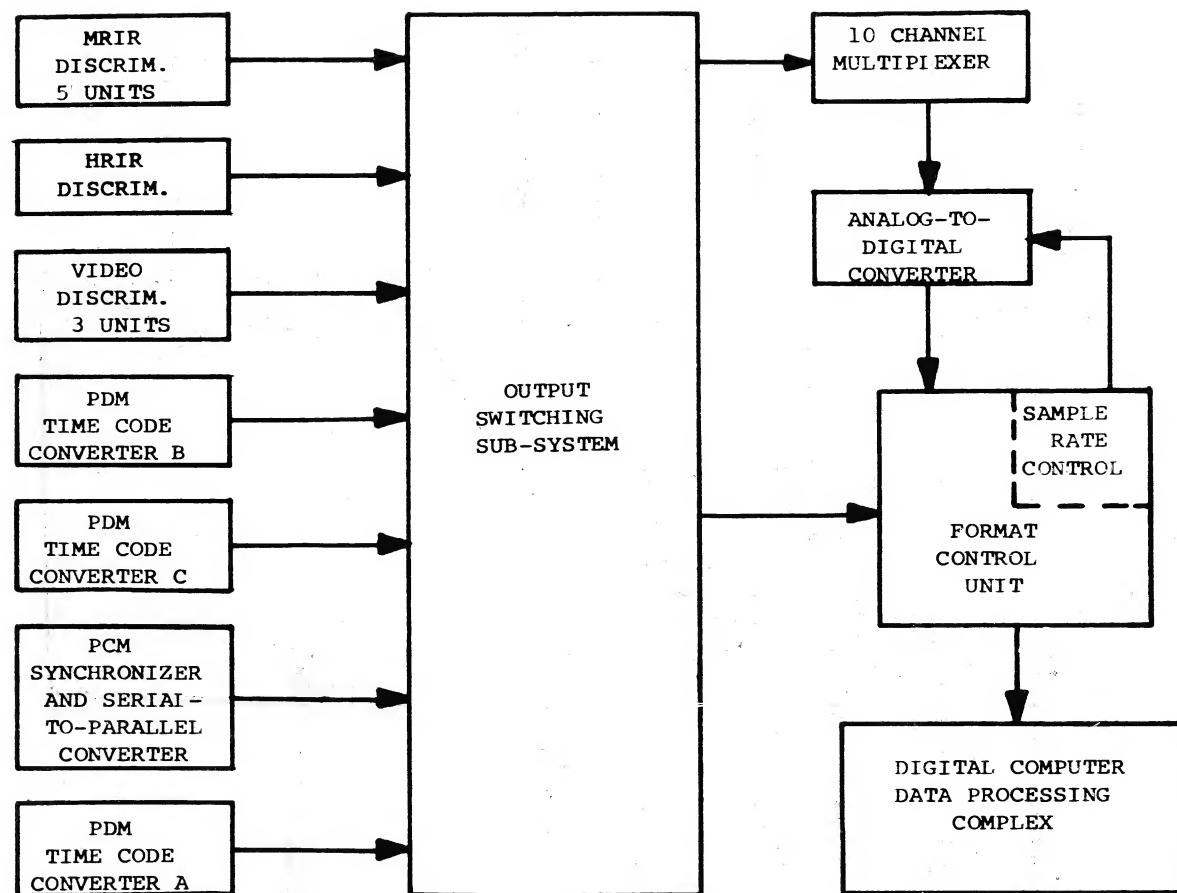


Figure 4. Output Processing Subsystem

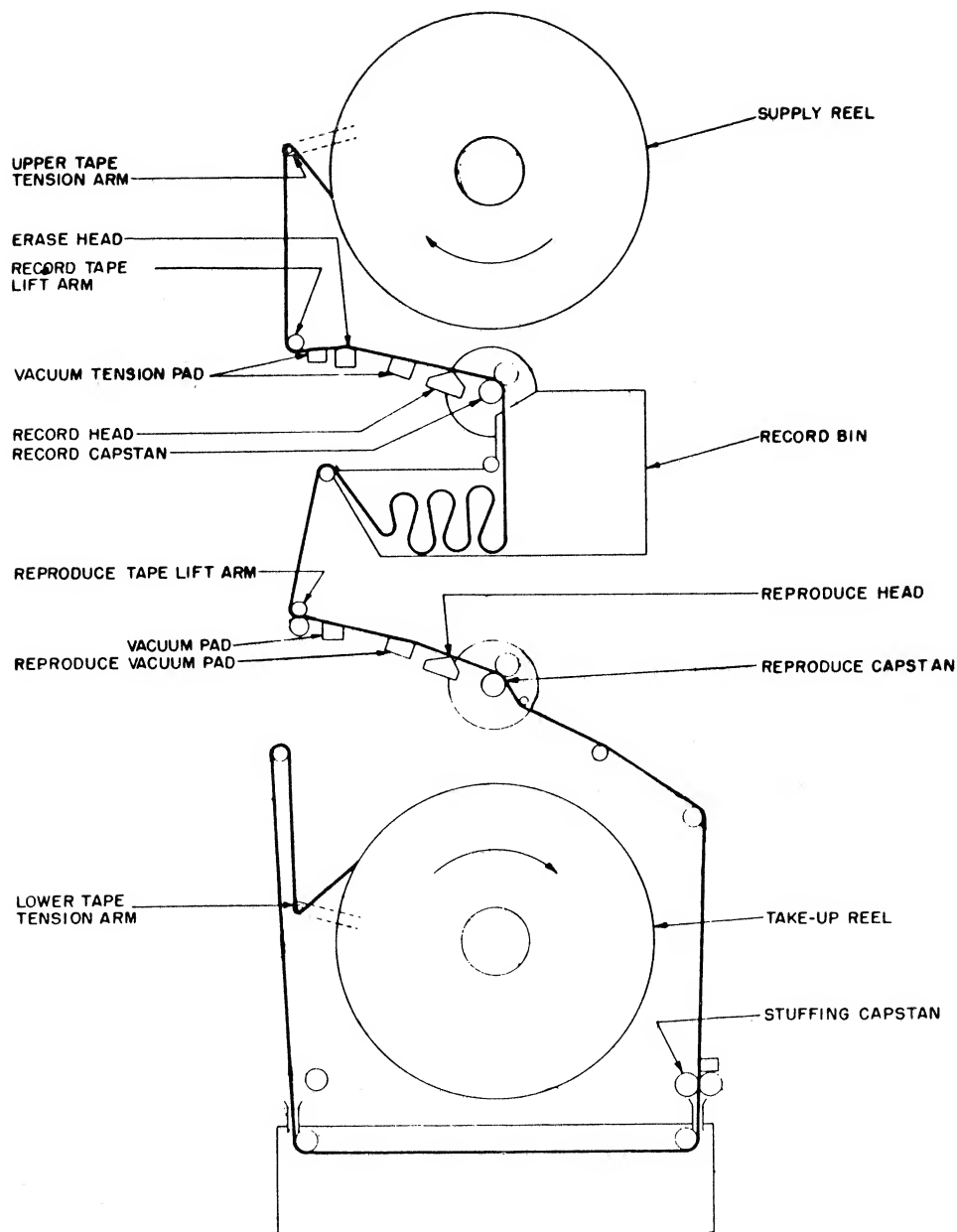


Figure 5. Bin Storage Tape Recorder

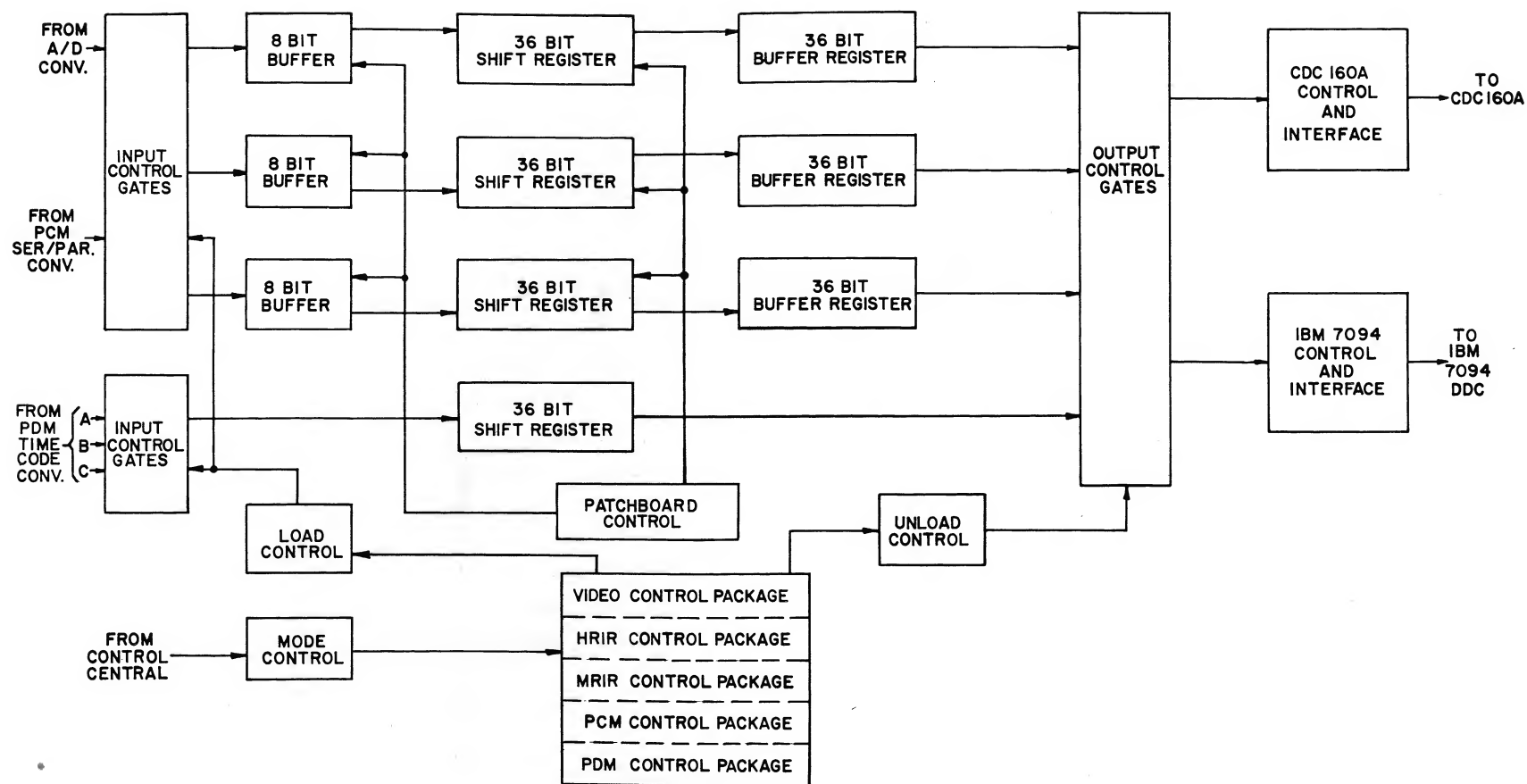


FIGURE 6. FORMAT CONTROL UNIT

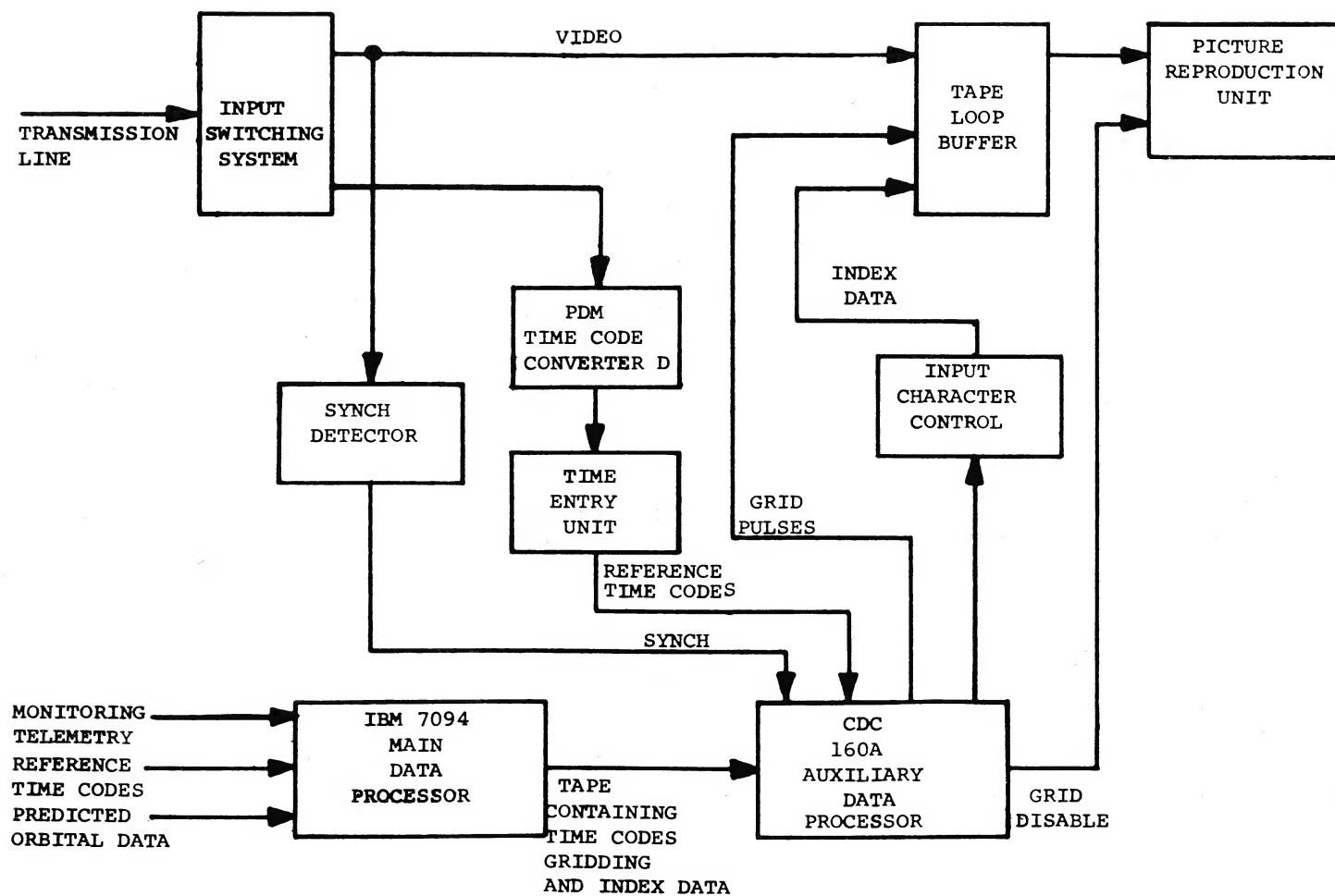


Figure 7. Gridding and Picture Reproduction Subsystem

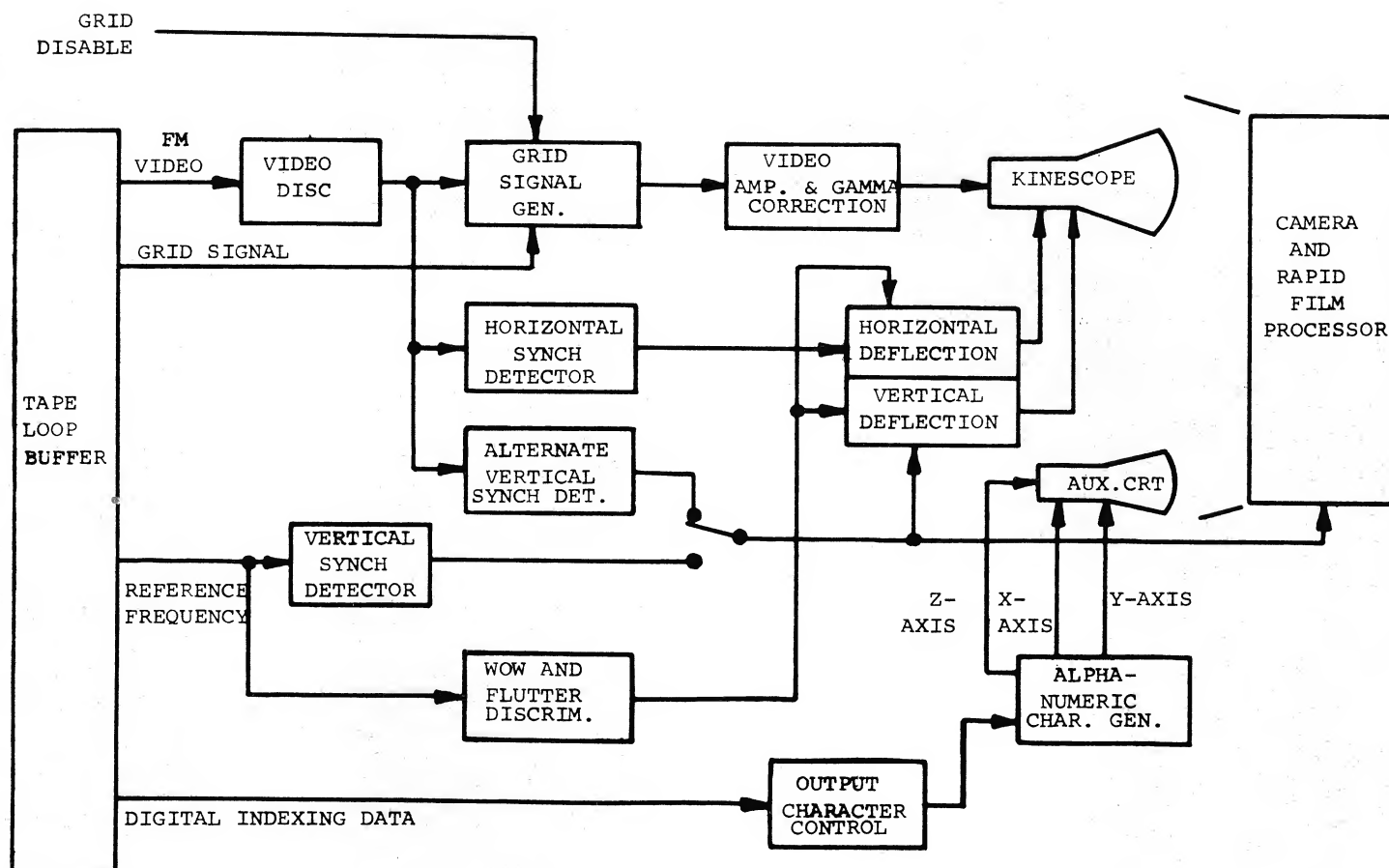
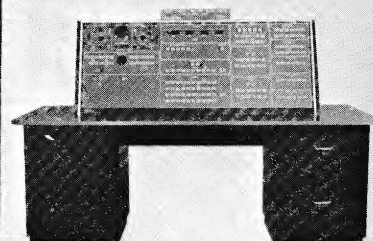
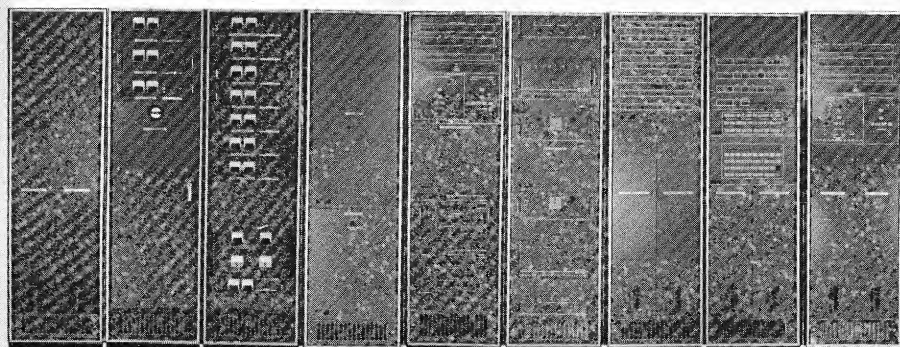
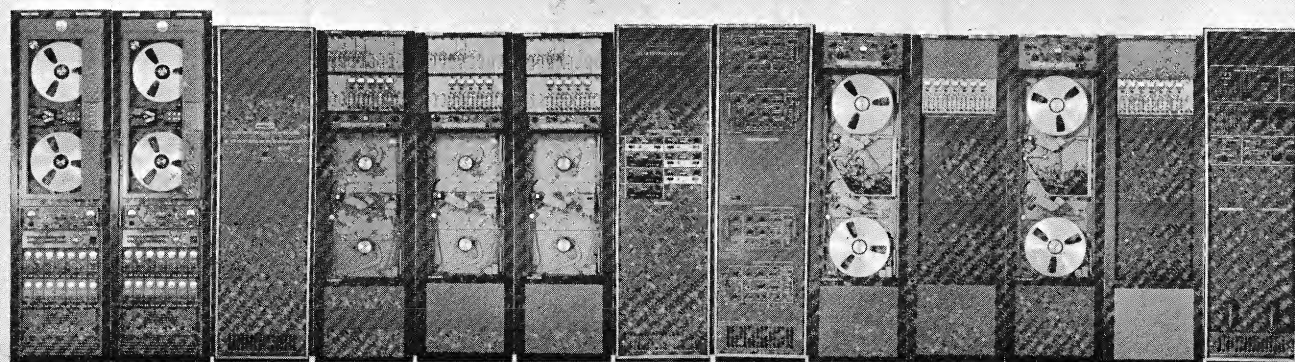


Figure 8. Picture Reproduction Subsystem



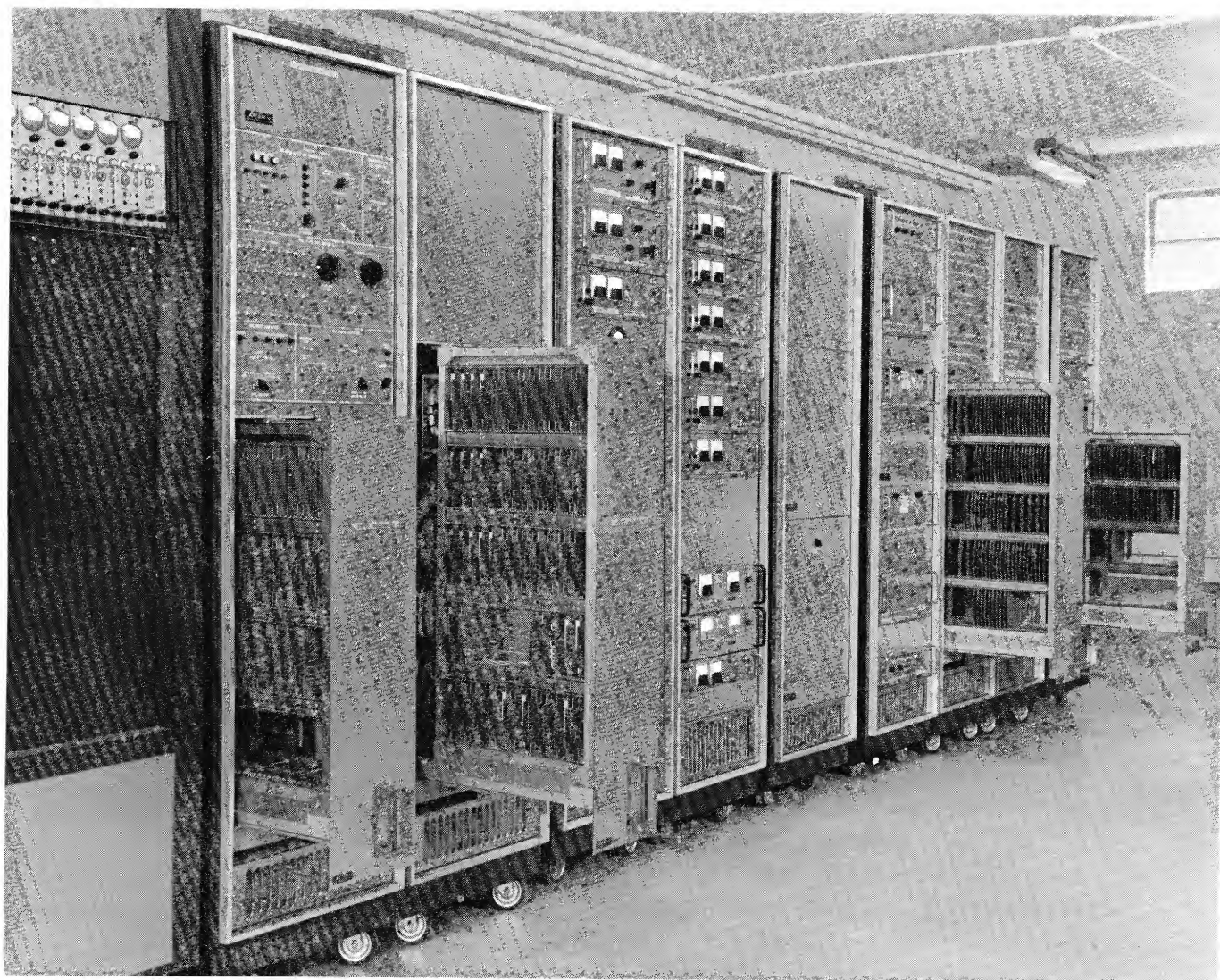
VIEW OF COMPUTER PORTION OF DATA PROCESSING AND ANALYSIS FACILITY
AT NATIONAL WEATHER SATELLITE CENTER



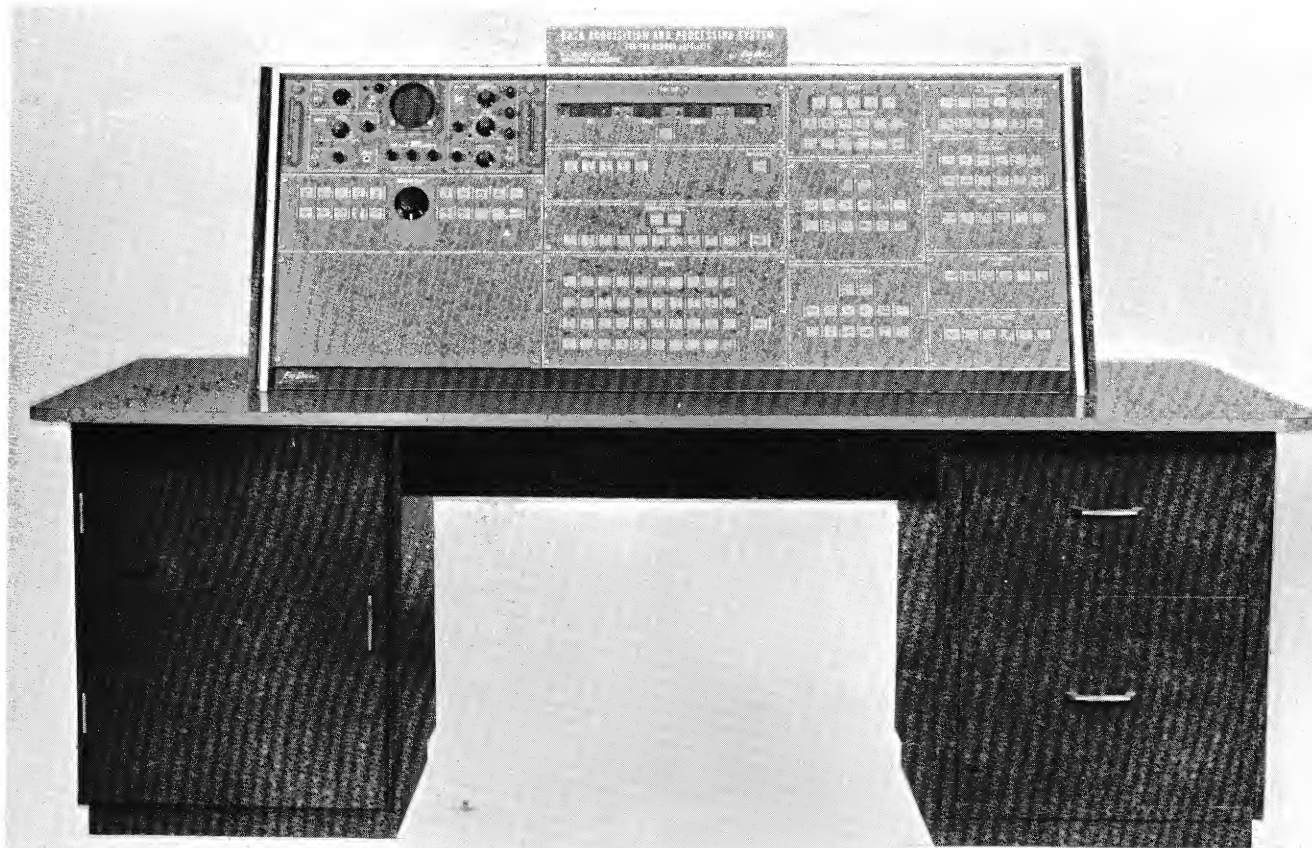
HIGH SPEED DATA ACQUISITION AND PROCESSING SYSTEM FOR THE NIMBUS
METEOROLOGICAL SATELLITE PROGRAM, DESIGNED AND BUILT UNDER
CONTRACT TO THE WEATHER BUREAU, U.S. DEPT. OF COMMERCE

ESS GEE, Inc.

1 Holland Ave. White Plains, N.Y.



SYSTEM RACKS WITH DRAWERS EXTENDED TO PROVIDE ACCESS TO PLUG-IN MODULES



CONTROL CONSOLE OF NIMBUS DATA ACQUISITION AND PROCESSING SYSTEM

AIRBORNE AND GROUND DATA HANDLING SYSTEMS

a. Airborne Data Systems

The U.S. Weather Bureau presently operates four airplanes specifically instrumented for meteorological research. This instrumentation was performed for the U.S. Weather Bureau by ESS GEE, Inc. Initially, three airplanes (two DC-6A's and a B-57A) were outfitted and put in service in 1960 primarily to meet the requirements for research on hurricanes utilizing the ESS GEE Digital Data Recording System.

Subsequently, an additional aircraft, a W-26C, was put into service in early 1961 primarily to conduct investigations of meteorological factors contributing to the development of severe local storms.

More recently, the capabilities afforded by each of these instrumented airplanes have been brought together into a single Weather Bureau organization, the Research Flight Facility, which now serves investigators of a number of different weather phenomena including hurricanes, severe local storms, extratropical storms, and jet stream conditions.

A continuing program is being carried out jointly by the Weather Bureau and ESS GEE, Inc., for improvement in the reliability and accuracy of the instruments, as well as expanding the total measurement capability.

b. System Description

ESS GEE, Inc., had the system responsibility for the electronics on two DC-6A's and one B-57 aircraft as a flying electronics "metro" laboratory. These aircraft are the heart of the Weather Bureau National Severe Storms Research Aircraft Project.

The "metro" equipment on the aircraft can measure up to 40 different parameters while in flight at sampling rates of up to twenty times per second.

A functional block diagram of the system is included in the following pages. Measurements include such pertinent weather information as wind speed, wind direction, air temperature, humidity, pressure, water content, etc., as well as aircraft information such as ground speed, latitude and longitude, roll and pitch angle, and drift angle. There are three radars on the aircraft. One is the standard surveillance radar in the nose of the aircraft and the other two radars, the APS-20E and the cross-sectional tail-mounted radar type RDR-1, are used for weather purposes.

A gust probe has been added to the aircraft for gathering more accurate information about the velocity and direction of air movements within storms.

The information received from the sensors are converted into digital form while in flight and placed on a magnetic tape at the rate of 6,000 characters per second. This tremendous volume of data is then processed after a mission, in a computer on the ground. A quick-look of the data is available in flight in either an analog strip chart recorder or on a printed read out.

Digital data recording is the primary system used on the DC-6A and the B-57A airplanes. An entire record consists of 24 computer "words" as recorded on a 3/4-inch section of the continuous magnetic tape. Record sampling rates are selectable for intervals ranging from 1/10 second to 1 minute.

The magnetic tape recording can be read directly by several types of standard ground digital computers and printed out in numerical form.

For back-up purposes, a photopanel system for recording key parameters is also provided.

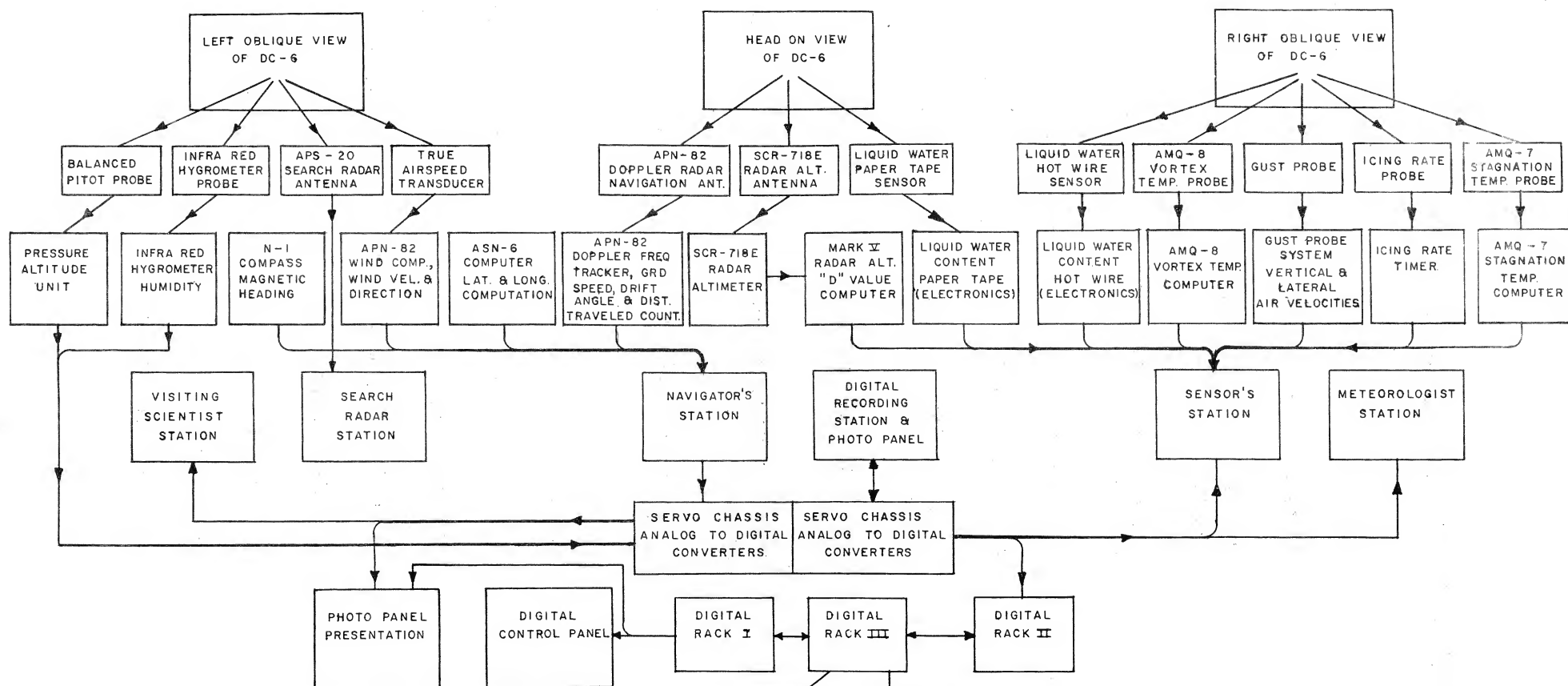
The reliability of the system has been proven during the last three years. It operated for 80 hours during Hurricanes Carla and Esther and recorded over 7 million observations without an error.

ESS GEE, Inc.
White Plains, N.Y.

H-A3

PARAMETERS RECORDED AND SENSING ELEMENT

<u>Parameter</u>	<u>Sensor</u>	<u>Maximum Sampling Rate</u>
DC-6A and B-57A		
Time	Crystal Oscillator	1/10 second
Latitude	Doppler Navigation System	1/10 second
Longitude	Doppler Navigation System	1/10 second
Heading	N-1 Compass	1/10 second
True Airspeed	Kollsman System	1/10 second
Ground Speed	Doppler Navigation System	1/10 second
Drift Angle	Doppler Navigation System	1/10 second
Wind Direction	Doppler Navigation System	1/10 second
Wind Speed	Doppler Navigation System	1/10 second
Roll and Pitch	Gyro Navigation System	1/10 second
Temperature	Vortex Thermometer	1/10 second
Temperature	Rosemount Probe	1/10 second
Humidity	Infra-Red Hygrometer	1/10 second
Radar Altitude	SCR-718 System	1/10 second
Absolute Pressure	Transducer	1/10 second
Diff. Pressure	Transducer	1/10 second
Icing	Cyclic-heated Probe	1/10 second



METEOROLOGICAL INSTRUMENTATION

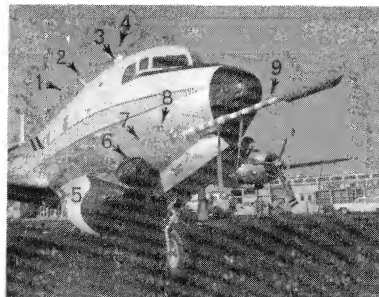
&

RECORDING SYSTEM

IN THE
FLYING RESEARCH LABORATORY
OF THE
U.S. DEPARTMENT OF COMMERCE
WEATHER BUREAU
OFFICE OF METEOROLOGICAL RESEARCH
(SEVERE STORMS)

ESS GEE INC.

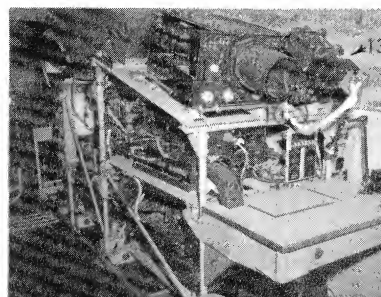
INSTRUMENTATION & RECORDING SYSTEM SPECIALISTS



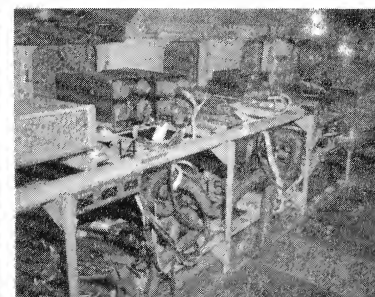
EXTERIOR VIEW (NOSE)



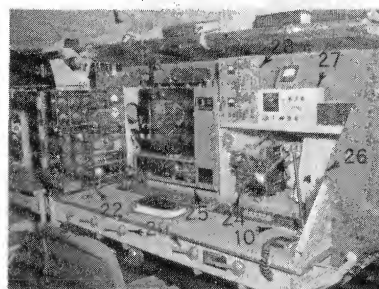
VISITING SCIENTIST'S TABLE



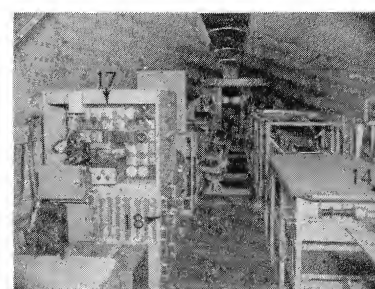
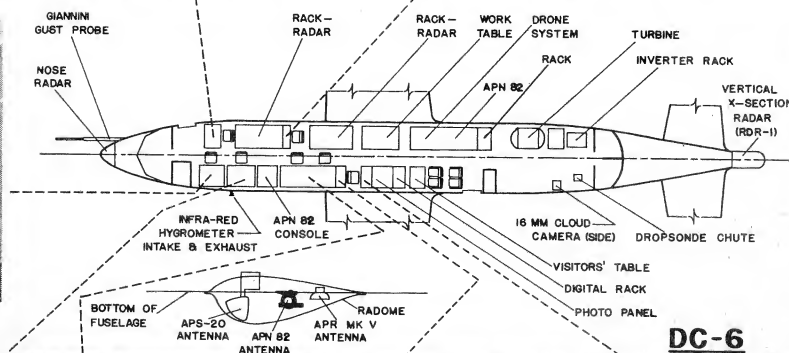
APS-20 RADAR OPERATOR'S CONSOLE



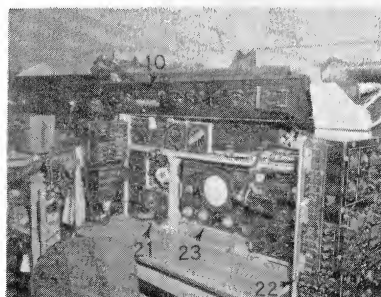
INTERIOR VIEW (RIGHT REAR)



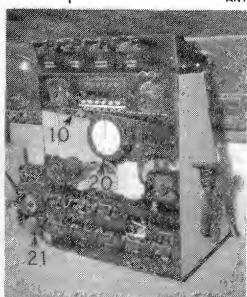
SENSOR CONSOLE



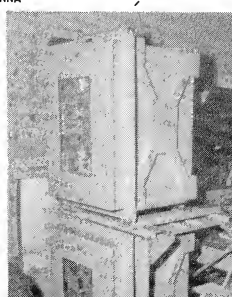
INTERIOR VIEW (LOOKING FORWARD)



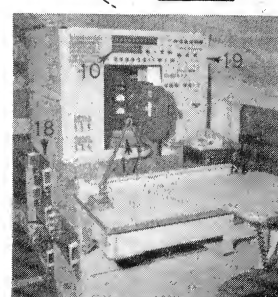
NAVIGATOR'S CONSOLE



FLIGHT METEOROLOGISTS' CONSOLE



AMPEX FR-400 RECORDER



DIGITAL CONSOLE AND PHOTO PANEL

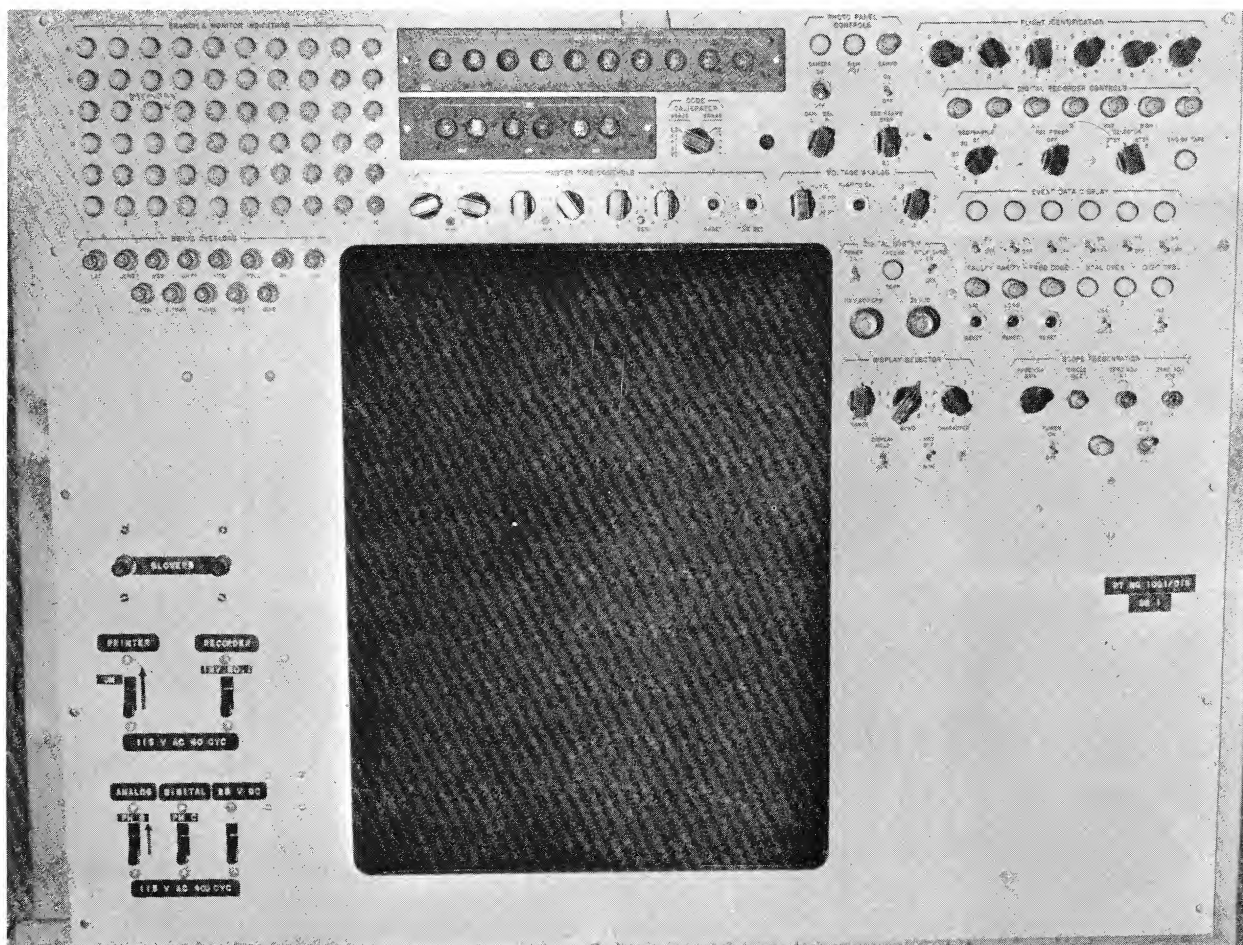


EXTERIOR VIEW (RDR-I RADOME)

1. VORTEX TEMPERATURE PROBE
2. ROSEMOUNT 102E TOTAL TEMPERATURE PROBE
3. LIQUID WATER PAPER TAPE HOUSING
4. LIQUID WATER HOT WIRE SENSING HEAD
5. RADOME (HOUSES 8 FT. SEARCH RADAR ANTENNA, DOPPLER ANTENNA, AND RADIO ALTIMETER ANTENNA)
6. 16 MM CLOUD CAMERA HOUSING (NOSE)
7. ICING RATE PROBE
8. ALTERNATE PITOT PRESSURE HEAD
9. GIANNINI GUST PROBE (WITH PROTECTIVE GROUND COVER IN PLACE)

10. TIME DISPLAY
11. NOSE RADAR REPEATER PPI SCOPE AND CAMERA ASSEMBLY
12. X-SECTION (RDR-I) RADAR SCOPE AND CAMERA ASSEMBLY
13. APS-20E RADAR SCOPE AND CAMERA ASSEMBLY
14. DRONE SYSTEM (IN PART)
15. APN 82
16. TURBINE POWERED GENERATOR
17. PHOTO PANEL
18. DIGITAL CARD DRAWERS

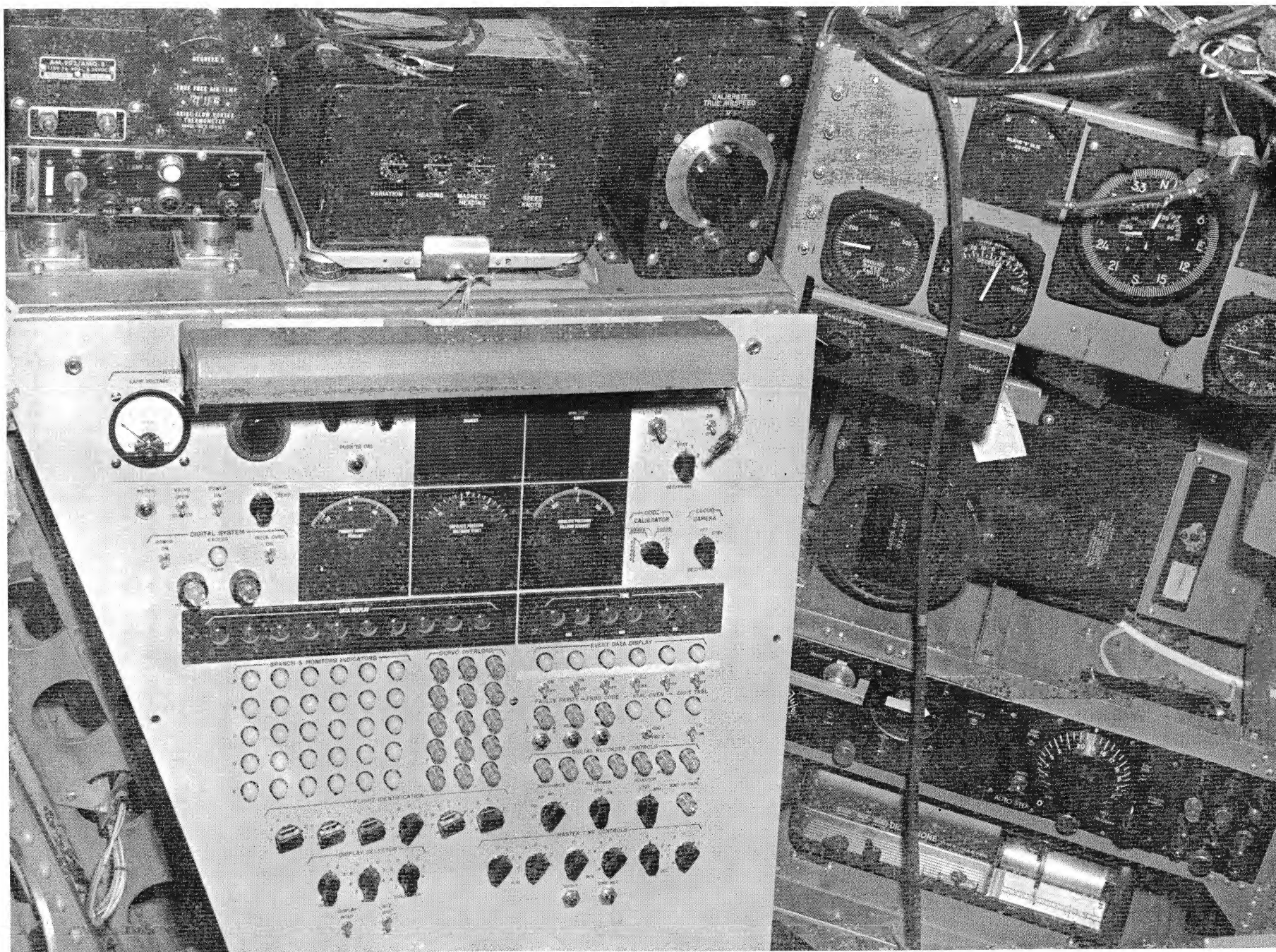
19. DIGITAL CONSOLE
20. APS-20E REPEATER PPI SCOPE
21. SCR-718 RADIO ALTIMETER
22. POWER PANEL
23. APS-20E REMOTE PPI SCOPE
24. VORTEX THERMOMETER AMPLIFIER AND INDICATOR
25. MK V RADIO ALTIMETER AND D-VALUE COMPUTER
26. LIQUID WATER HOT WIRE INSTRUMENT
27. LIQUID WATER PAPER TAPE CONSOLE
28. SILVER IODIDE BURNER CONTROLS
29. INFRA-RED HYGROMETER INTAKE AND EXHAUST CONTROLS



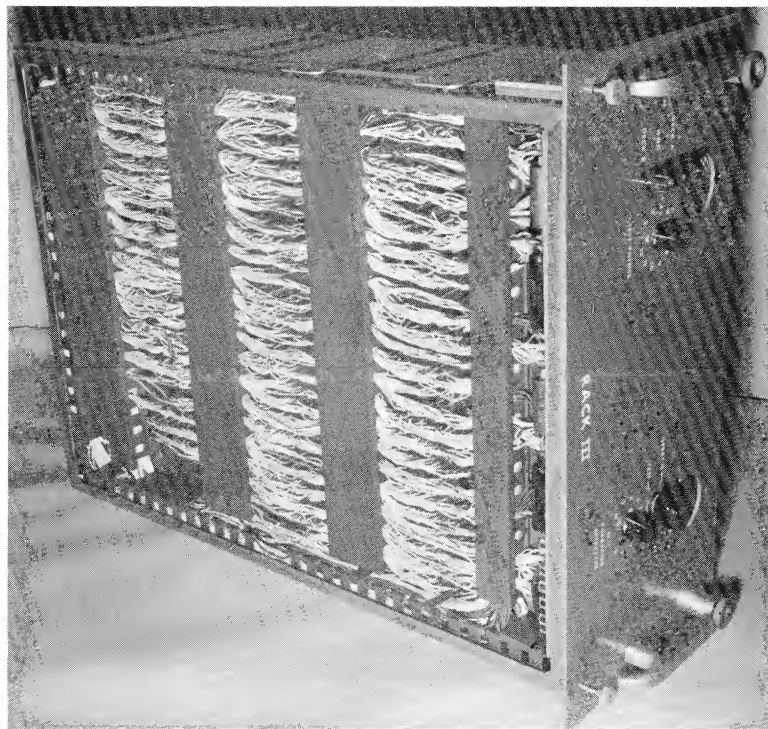
Control Panel for DC-6 Airborne Instrumentation & Recording System
(under fabrication in Jan. 1961)



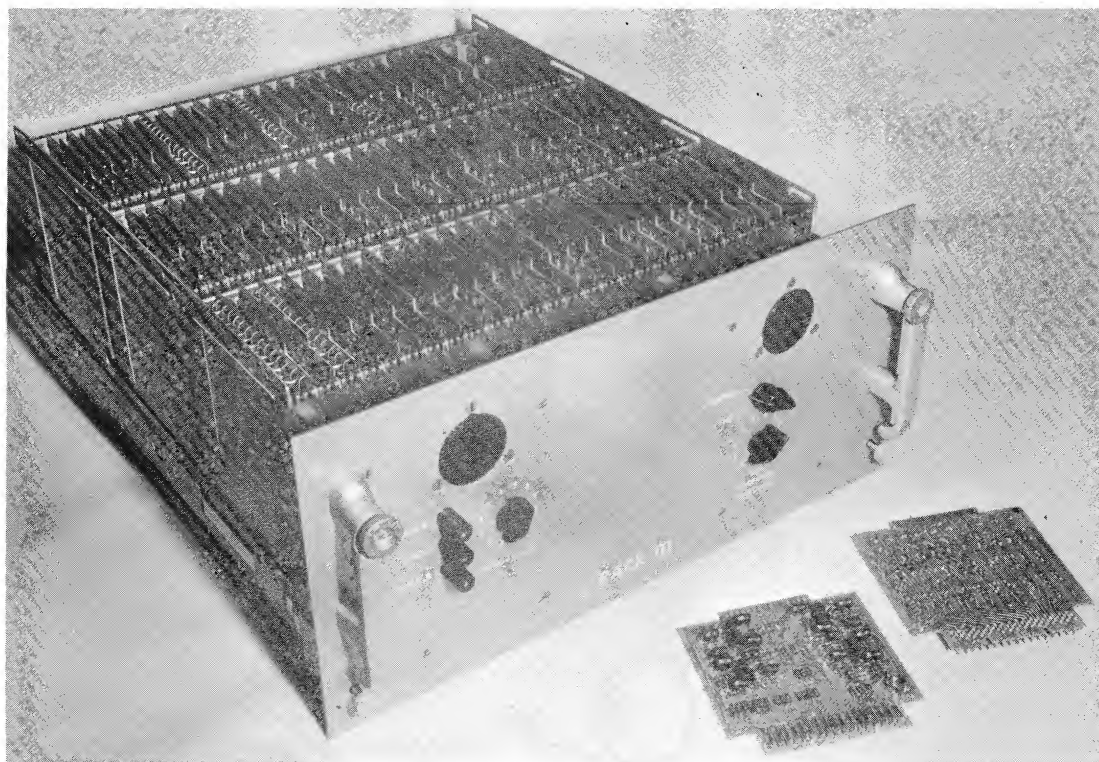
"HURRICANE HUNTER" Flying Research Laboratory of U.S.W.B. (DC-6A)



Control Panel for B-57 Airborne Instrumentation and Recording System (installed)



Bottom View of Logic Drawer



Logic Drawer for Airborne Digital
Magnetic Tape Recording System

SEVERE STORMS DRONE PROGRAM

During the fall of 1961, it was suggested to the Severe Storms Section of the U. S. Weather Bureau that remote control drones be used for severe storms penetration. The drones would be attached with meteorological sensors for measuring weather parameters and would transmit this information to the DC-6 aircraft or to a ground station. A brief description of the drones and the information system follows:

The drone selected was a KDB-1 as shown in the following photographic reproduction. The KDB-1 drone is a pilotless all-metal high-wing monoplane designed for remote insight or out-of-sight control from ground to air. The use of radar reflectors in the wing tip pods and on the tail cone permits radar tracking. The drone is operational from sea level to 43,000 feet. It has a wing span of 145 inches and an overall length of 181 inches.

Actual flight speed at sea level is 240 knots. The drone can carry a payload of up to 200 pounds with a maximum of 50 pounds in each wing tip pod. The drone is recoverable after each flight through a built-in recovery system.

Support equipment consists of ground launching equipment, ground control and tracking equipment, and an item of checkout and test equipment.

The meteorological transducers for (1) airspeed indicator, (2) vortex temperature, (3) rate of climb, and (4) pressure altitude, are located in one of the wing tip pods. There could be up to 10 channels time-shared if required.

Each transducer generates a DC voltage that is proportional to the magnitude of the parameter being sensed. These DC voltages are fed into extremely linear DC amplifiers. The DC amplifiers are also located in the wing-tip pod in order to realize a high signal-to-noise ratio. The output of the DC amplifiers is routed to voltage-controlled oscillators. VCO's numbered 1,2,3,4 generate subcarrier frequencies of 14.5 KC, 22 KC, 30 KC and 40 KC, respectively. The output voltage, from the DC amplifiers, frequency modulates its

respective subcarriers. The deviation of the subcarrier does not exceed $\pm 7.5\%$. The output of the VCO's is a frequency proportional to the magnitude of the DC input. (See the following attached drawings.)

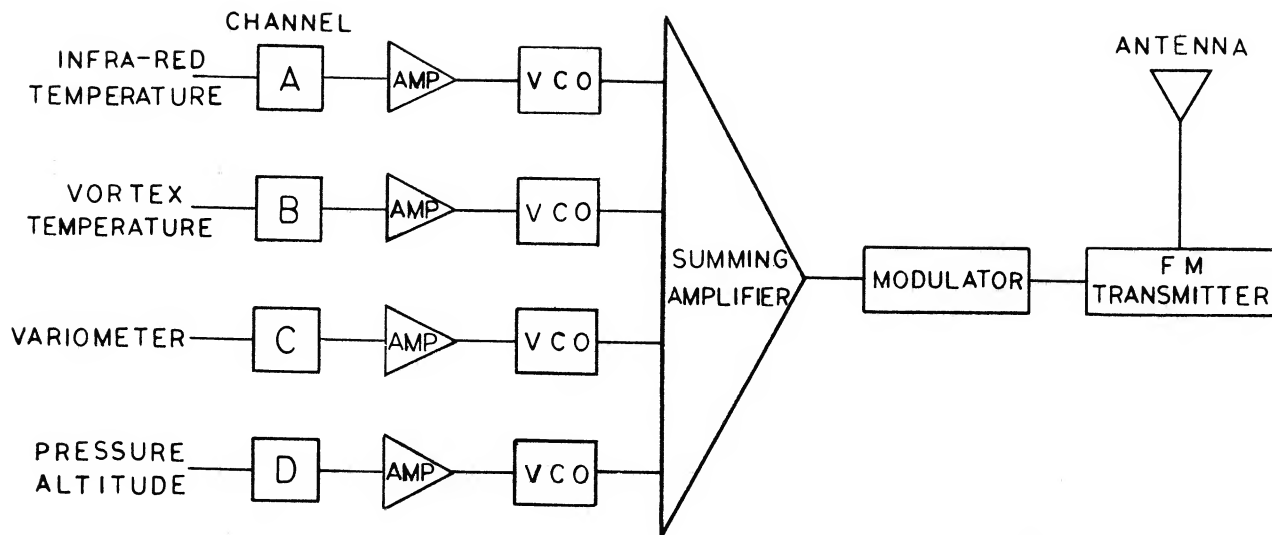
Since all parameters go through the same evolution, they must be combined prior to transmission to the receiving aircraft or ground station. The summing amplifier accomplishes this. It also amplifies the four parameters and limits them, while at the same time preserving their individuality. The output of the summing amplifier feeds the modulator which combines the intelligence of the summing amplifier with an RF signal. This modulated RF signal is then amplified in the FM transmitter and transmitted via the antenna to the receiving aircraft or ground station.

KDB-1 MISSILE TARGET

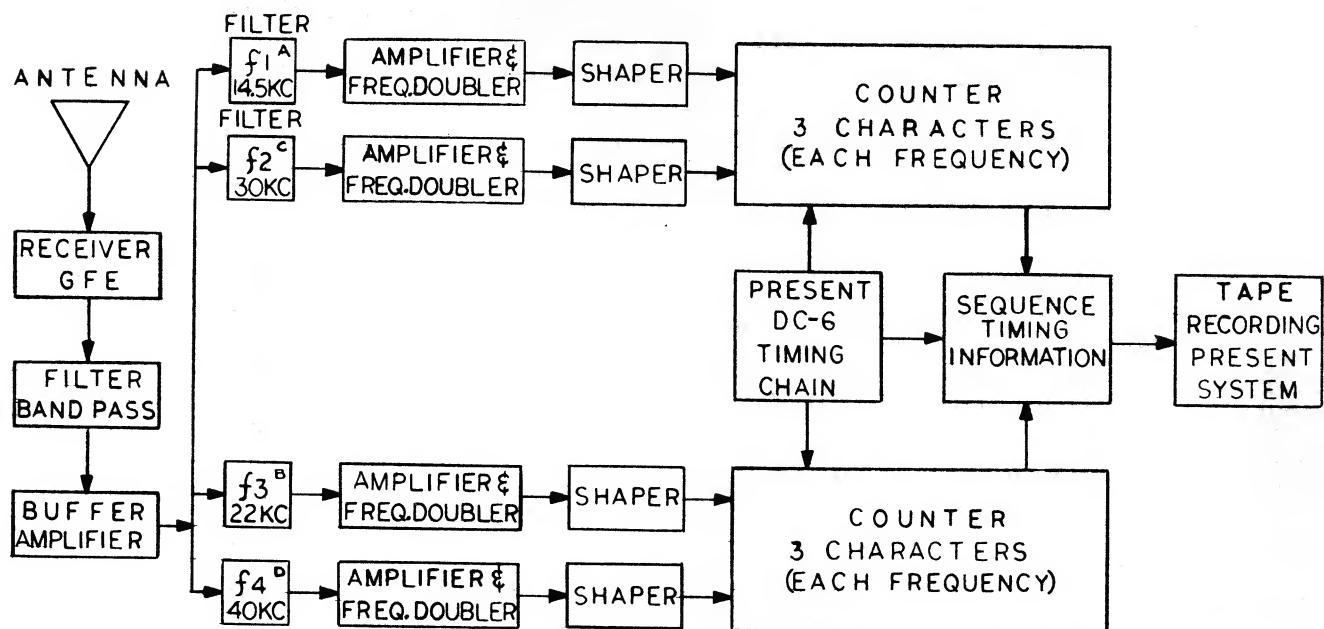
KDB-1 AFTER 26 SUCCESSFUL
MISSIONS. THIS TARGET HAS ATTAINED
43,875 FT. ALTITUDE

BEECH AIRCRAFT CORPORATION

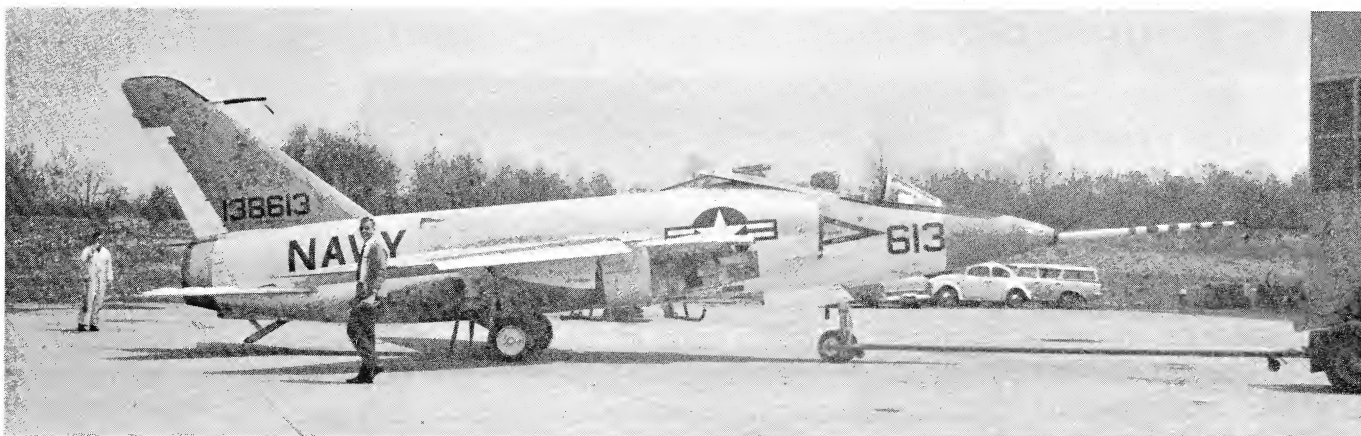




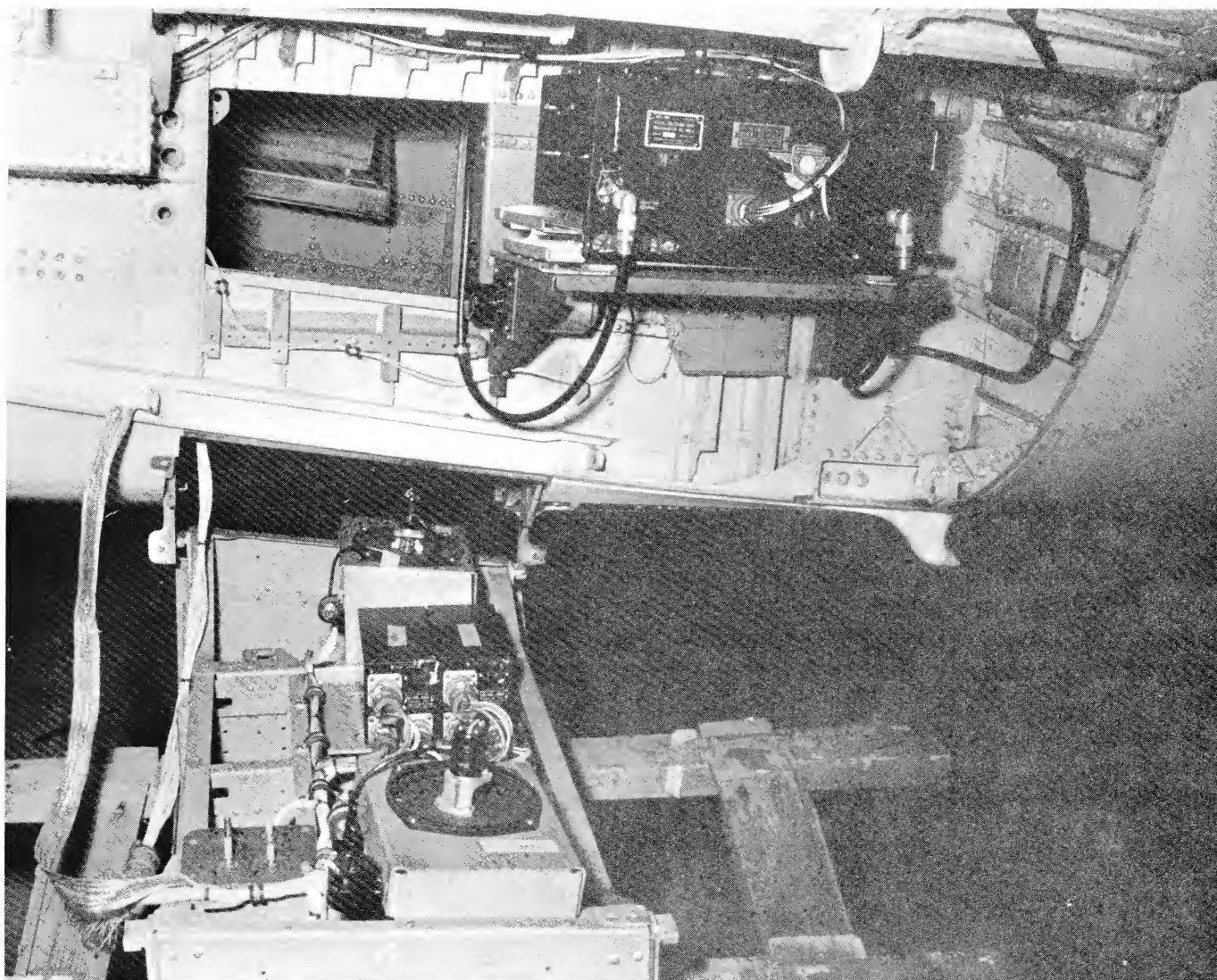
DRONE TRANSMITTING SYSTEM



DRONE RECEIVING SYSTEM



Severe Storms Meteorological Research Aircraft (F11F)
Instrumented with Recording System Designed, Fabricated,
and Installed by ESS GEE, Inc.



INSTRUMENTATION EQUIPMENT INSTALLED IN LOWER HATCH AND LEFT SIDE
COMPARTMENT OF F-11 AIRCRAFT

ESS GEE, Inc.
White Plains, New York

F-11-F AIRCRAFT INSTRUMENTATION

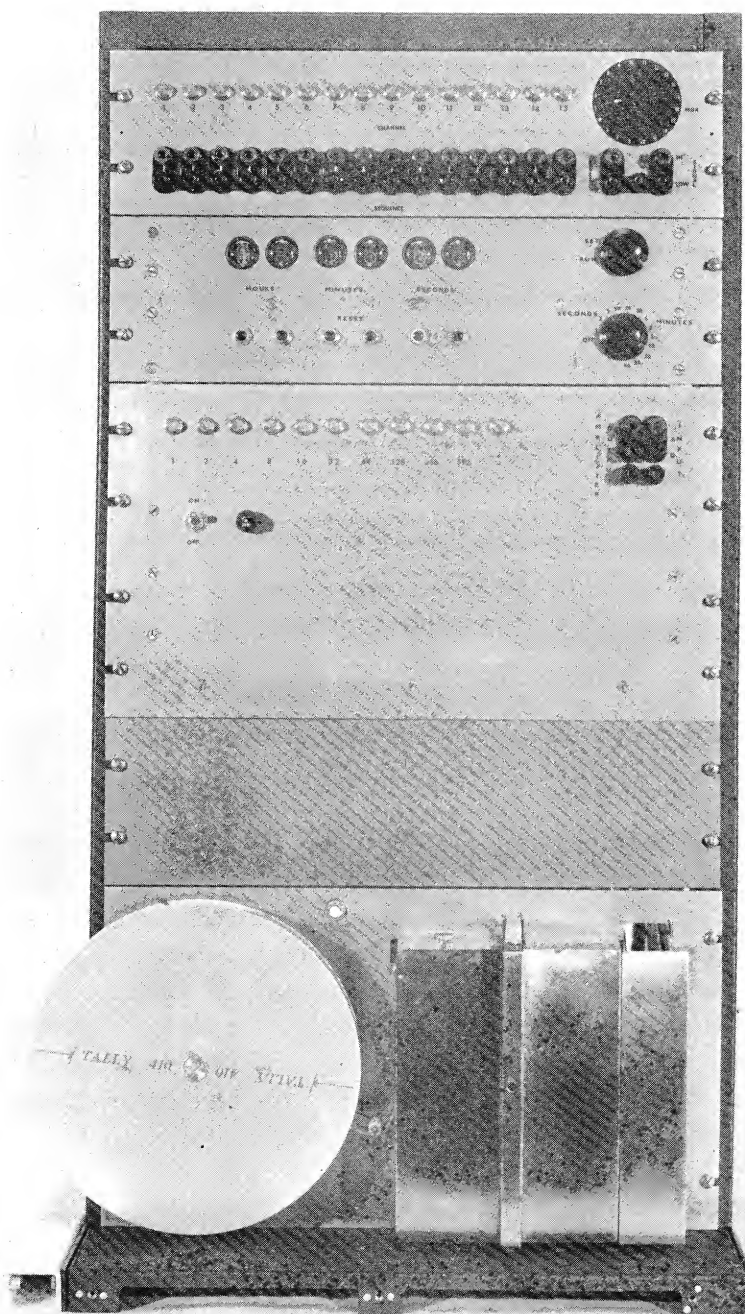
Installation of a Meteorological Sensing and Recording System was completed by ESS GEE on an F-11-F fighter type jet aircraft in November 1963. The system was designed for use in obtaining data within severe storms, squall lines, and other meteorological phenomena for research purposes. It was delivered to the U.S. Weather Bureau after successful performance of both ground and flight checkouts at ESS GEE.

The system is comprised of the following equipments and sensors:

- a. Complete TACAN Installation for Azimuth and Range Navigation Information.
- b. Static and Total Pressure Probe and Transducers
- c. Temperature and Humidity System AMQ-7-(Stagnation Probe)
- d. Temperature System (Rosemont Probe)
- e. Magnetic Heading
- f. Timing System and Real Time Indicator
- g. Automax Model 1G 35mm Camera
- h. SCR-718 SCR Altimeter System
- i. Attitude Gyro

All probes and antennas were mounted on the skin of the aircraft with FAA-DER approvals of the structural mountings to meet air loads at Mach $1\frac{1}{2}$. Weight and balance calculations showing aircraft CG were performed during and after the installation.

All mechanical, sheetmetal, plumbing, and electrical installations were performed in accordance with FAA standards as defined in Civil Aeronautics Manual 18 and equivalent military specifications.



ESS GEE's 15-CHANNEL, LOW-LEVEL
DIGITAL DATA RECORDING SYSTEM

0-5mv input
15 input channels of
analog data
0.1% accuracy
selectable sampling rates

20 channels/sec conversion
less than 5 μ v noise
input/output programming
silicon logic

ESS GEE, Inc.
White Plains, New York

DIGITAL DATA RECORDING SYSTEM, MODEL 1166

The Model 1166 System is a low-level Data Acquisition and Recording System design to accept up to 15 voltage inputs in the range of zero to 5 millivolts. It measures each input with an accuracy of 1 part in 1000 (0.1%) and records each measurement, along with real time and an input channel identifier, on punched paper tape in a format compatible for computer injection.

The system is designed for mounting in a standard 19-inch equipment rack and consists of the following major items:

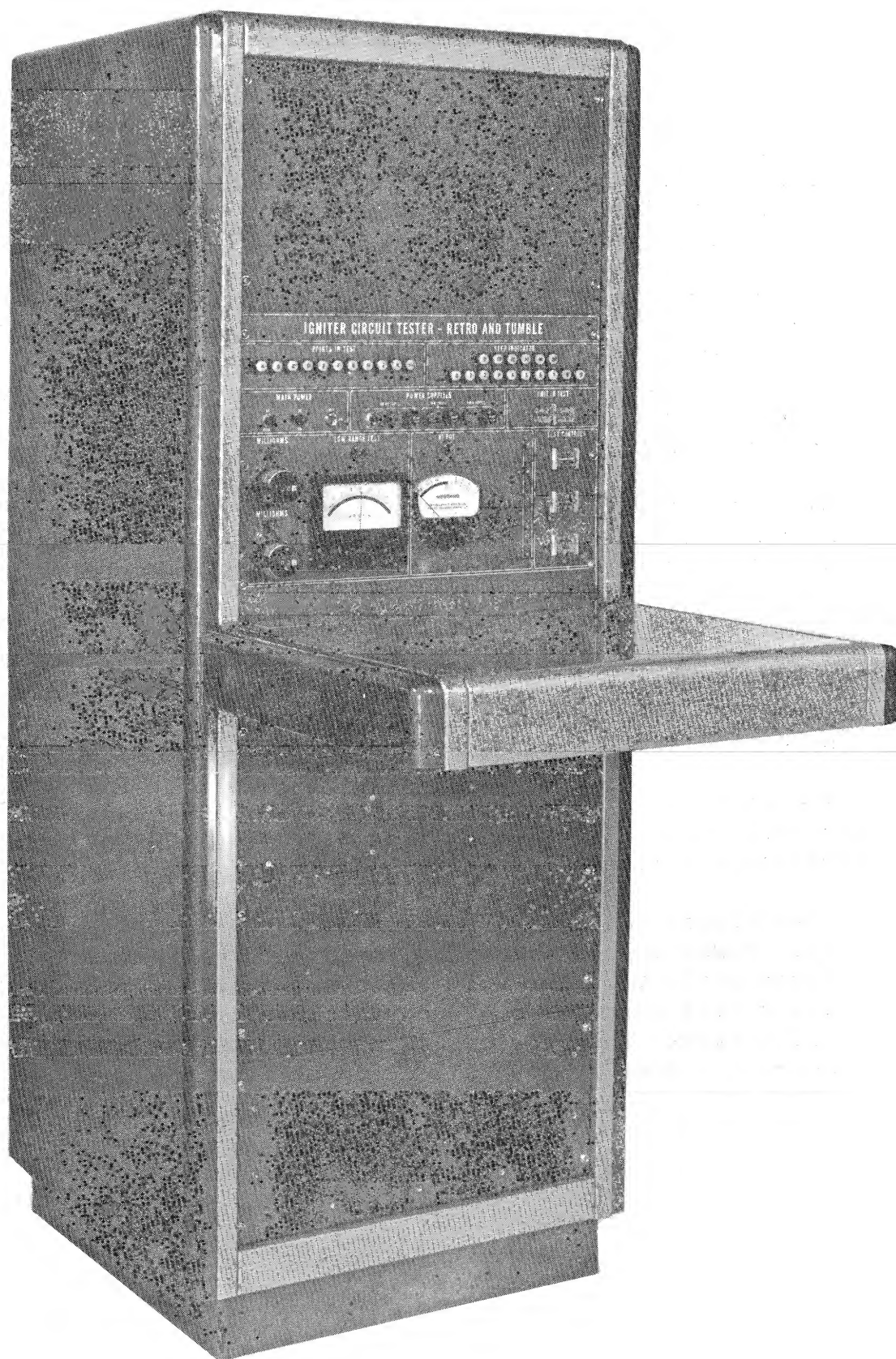
- a. Real Time Digital Clock
- b. 15-Channel Input Multiplexer
- c. 10-Bit-Plus-Sign Binary A/D Converter
- d. 8-Level, 60-Character-per-Second Paper Tape Perforator
- e. Programmer

Additional multiplexer units can expand its handling capacity and operational capabilities by up to 15 input signals each.

The system features the capability of programming the order of input signal selection sequence. Receptacles on the front panel can be patch wired for sequential signal selection or for random signal selection. Random signal selection is generally employed when a combination of both fast changing and slow changing input signals are connected to the system. To get a true analysis of the fast changing inputs, it is necessary to sample/record these inputs more frequently than the slower changing inputs. Another feature is the visual display which indicates the input signal being processed.

The system records at a rate of 10 inputs of 5 characters each per second and has a selectable recording rate interval, variable from 1 per second to 1 per hour. The character punching rate is 60 per second.

The system is all solid-state electronics with reed relays and is designed with a high noise immunity. It operates on 115 VAC, 60 cps, and consumes approximately 700 watts.



EXTREME RANGE RESISTANCE TESTER
(1 MILOHM to 1 MEGOHM)

ESS GEE, Inc.
White Plains, New York

EXTREME RANGE RESISTANCE TESTER

ESS GEE's semiautomatic Extreme Range Resistance Tester provides a means of rapid checkout of low resistance of cable wires and high resistance between cable wires. Junction boxes are furnished for two different types of cables, and a different sequence of steps is provided for each type.

Low resistance measurements are made by means of two potentiometers, one measuring 0-100 milliohms and the other 0-1000 milliohms. Measurements are made by using the potentiometers in a bridge circuit to zero the reading of a voltmeter on the front panel. This method provides an accuracy of $\pm 0.5\%$ of full scale between 0 and 1000 milliohms.

High resistance, insulation measurements are made by means of a megohmmeter installed within the equipment. 10, 100, 1K, 10K and 100K megohm ranges are available for these requirements.

Actual testing is performed by successively pressing a stepping button which automatically connects the test specimen across either the potentiometer bridge circuit or the megohmmeter. The sequence selected by the stepper is preprogrammed and tests are determined by plug and patch wiring.

The main panel of the test set provides in-line, light indications of the points in test as well as a numeric indication of the number of steps completed in a particular test.

The unit operates from a power source of 117 VAC $\pm 20\%$ at 60 cps $\pm 10\%$. Power supplies for low resistance measurements are current limited at 50 ma. The unit employs completely modular design and all critical circuits are epoxy encapsulated to provide a tamper-proof system. An interlock is provided on the access door whereby opening the door removes all AC power from the unit.

ANGULAR TRANSDUCERS

Conversion of the angular position to a highly accurate digital readout often has presented a problem. If we consider that the angular position of a potentiometer which is excited by an extremely accurate DC reference voltage is to be digitized, the problem in providing the end result is manageable. We would sense the shaft position of the potentiometer and utilize a conventional analog-to-digital converter to provide the desired output. However, if we wish to accurately digitize the angular positions of synchros or resolvers, we are dealing with AC voltages where the amplitudes of their envelopes are an indication of the shaft position of the device.

A technique has been developed by ESS GEE, Inc., which essentially converts the angular position into a phase shift angle, at the reference frequency which excites the synchro or resolver. The electrical waveform containing this phase shifted signal is then compared to the AC reference signal and a digital indication (specific number of pulses linearly proportional to the phase shift) of the phase shift is provided as an output in either a serial or parallel format. This output may then be used in a multitude of ways (i.e. ingestion into a digital computer, digital servo control, counter displays, etc.).

The device now being developed by ESS GEE, Inc., has an accuracy of 6 minutes referred to a full scale of 360° .

HIGH SPEED PLOTTER

One of the basic techniques involved in the recording and display of data is the high-speed projection of a point of light. This projection can be used, as in television, to present a large number of points at such speeds that the resultant picture can be viewed as a whole; or, as in high-speed plotters, to permanently record data on a photosensitive surface.

The High Speed Plotter now under development by ESS GEE, Inc., presents an entirely new and different concept in the field of Plotting. Its operation is very similar to that of a cathode-ray tube including frequency response, except that no vacuum vessel is required. Through the use of a special light gun and a special means of deflecting this light, direct viewing analog plots can be made on very large screen displays. A theoretical analysis has shown sufficient promise in our approach to warrant an advance development program. A breadboard is now under construction, and we expect to demonstrate a working feasibility model by the end of this year.

Angular position can be converted to a dc voltage without the use of servo-mechanisms. Only a few standard electronic circuits are needed to accomplish the job.

By Sol N. Koblick

THE ANGULAR POSITIONS of synchros or resolvers can be converted to accurate dc voltages using position servomechanisms; however, in missile work (the primary application for such a system), weight, reliability and economy are of the utmost importance. Therefore, a new method for providing linear conversion of angular displacement versus dc voltage is necessary. This article considers the necessary instrumentation for the synchro and resolver and discusses the important features of the suggested circuitry together with its associated errors.

Trigonometric Phase Shift Circuitry for Angular Conversion

A synchro rotor, R , excited by an ac voltage of proper magnitude and frequency, produces specific voltages across its stator, S , windings. If the rotor assumes an angular displacement from its neutral position, the voltages induced in the stator windings, including the effects of quadrature, are shown in Fig. 1. The relationships are given by

$$E_{s1n} = E_R \cos \theta [\sin \omega t + q \cos \omega t]; \quad (1a)$$

$$E_{s2n} = E_R \cos [120^\circ + \theta] [\sin \omega t + q \cos \omega t]; \quad (1b)$$

$$E_{s3n} = E_R \cos [120^\circ - \theta] [\sin \omega t + q \cos \omega t]; \quad (1c)$$

where $0 \leq q < 1$.

The stator voltages, indicated in Fig 1, are available with respect to node n , but it is desired to have these expressed with respect to ground. This may be accomplished by adding, vectorially, certain stator voltage combinations. The combination of the stator voltages is shown in Fig. 2A, and is obtained by using transformers having zero phase shift at the frequency of operation.

The configuration of the transformers shown in Fig. 2A provides a simple descriptive presentation of the vector summations required of the stator voltages E_{s1n} , E_{s2n} , and E_{s3n} , and are expressed as

$$E_{s1n} = E_R \sqrt{1 + q^2} \sin(\omega t + \gamma) \cos \theta; \quad (2)$$

$$E_{s2n} = E_R \sqrt{1 + q^2} \sin(\omega t + \gamma) \left[-\frac{\cos \theta}{2} - \frac{\sqrt{3}}{2} \sin \theta \right]; \quad (3)$$

$$E_{s3n} = E_R \sqrt{1 + q^2} \sin(\omega t + \gamma) \left[-\frac{\cos \theta}{2} + \frac{\sqrt{3}}{2} \sin \theta \right]; \quad (4)$$

Author: Sol. N. Koblick is director in charge of research, development, and hardware fabrication of electronic circuitry for digital and analog devices at Ess Gee, Inc., White Plains, N. Y.

where $\gamma = \tan^{-1}q$; $0 \leq q < 1$.

The voltages, E_A and E_D , which result from the transformer summing networks, are indicated by

$$E_A = \frac{E_{s3n} - E_{s2n}}{3\sqrt{3}} = \frac{1}{3} E_R \sqrt{1 + q^2} \sin \left[\omega t + \gamma \right] \sin \theta; \quad (5)$$

$$E_D = \frac{2E_{s1n} - E_{s2n} - E_{s3n}}{3} = \frac{1}{3} E_R \sqrt{1 + q^2} \sin \left[\omega t + \gamma \right] \cos \theta. \quad (6)$$

Use of a resolver enables the two voltages from the stator to be available as outputs referred to a common reference. In Fig 2B, a resolver is shown whose rotor assumes θ with respect to the vertical and whose voltage outputs from the two stator windings, including the effects of quadrature, are indicated by

$$E_{K1} = E_R \sqrt{1 + b^2} \sin \left[\omega t + \chi \right] \cos \theta; \quad (7)$$

$$E_{K2} = E_R \sqrt{1 + b^2} \sin \left[\omega t + \chi \right] \sin \theta; \quad (8)$$

where $\chi = \tan^{-1}b$; $0 \leq b < 1$.

The voltages, E_{K1} and E_{K2} , are proportional to the voltages, E_A and E_D , respectively. For the remainder of this article, therefore, E_A , E_D , and q will be used to describe the operation of the converter. Note that no computing transformers are necessary when using a resolver, and this minimizes potential sources of error. Signals E_A and E_D are now combined in the manner illustrated by Fig. 3.

The network of Fig. 3, which provides the phase shift of -90° deg, has purposely been chosen as a lag network. Note that a network providing a phase shift of $+90^\circ$ deg could also have been used, but this type of structure accentuates high frequencies, which is undesirable insofar as high frequency noise is concerned. The output voltage, E_o , resulting from the network shown in Fig. 3, is expressed by

$$\begin{aligned} E_o &= H E_A \angle -90^\circ + H E_D \\ &= \frac{H}{3} E_R \sqrt{1 + q^2} \left[\sin(\omega t + \gamma - 90^\circ) \sin \theta \right. \\ &\quad \left. + \sin[\omega t + \gamma] \cos \theta \right] \end{aligned}$$

$$= -\frac{H}{3} E_R \sqrt{1 + q^2} \sin(\omega t - \theta + \gamma). \quad (9)$$

The angular displacement of the synchro has now been referred to an angular phase shift at the frequency of operation. Furthermore, the quadrature effect, identified by the angle γ , contributes only a small effect to the resulting output error. The final instrumentation for the dc output voltage versus angular displacement is instrumented as indicated in Fig. 4.

The reference signal, E_i , and the output signal, E_o , are applied to squaring amplifiers which operate at the zero crossover points of the applied signal. It is desirable for these amplifiers to operate as close to the zero crossover points as possible. This method of operation is possible only if high gain amplifiers are employed. The gain is limited by the magnitude of the noise signals present in the squaring amplifiers and in the signals E_i and E_o . Furthermore, these squaring amplifiers must be relatively stable with respect to each other insofar as their zero crossover detection capabilities are concerned.

The signals created at the various parts of the circuitry, indicated in Fig. 4, are shown in Fig. 5. The signals, E_{is} and E_{os} , from the outputs of the squaring amplifiers, are respectively differentiated in circuits D_1 and D_2 . The signals E_{ip} and E_{op} provide the set and reset operation for the flip-flop. Note that signals

E_{ip} and E_{op} contain both positive and negative pulses, and it has been arbitrarily assumed that the set and reset inputs to the flip-flop will only respond to positive pulse inputs. This is not a specific requirement for the operation of this device, because a flip-flop responding only to negative pulses will also suffice. The important consideration is to have the flip-flop respond to pulses of only one polarity. The waveform emanating from the flip-flop is E_{pm} whose peak voltage is controlled via an accurate source of voltage such as a stable zener reference diode. The dc output voltage, E_{dc} , from the filter is proportional to the duty ratio of the signal, E_{pm} , and expressed by

$$E_{dc} = \frac{k\theta|E_{pm}|}{360^\circ} - \frac{k\gamma|E_{pm}|}{360^\circ}, \quad (10)$$

where $\gamma = \tan^{-1}q$; $0 \leq q < 1$; $0^\circ \leq \theta < 360^\circ$.

k = dc attenuation constant of the filter, F , shown in Fig. 3.

The term $k\theta|E_{pm}|/360^\circ$ represents the desired output, and $k\gamma|E_{pm}|/360^\circ$ represents the error voltage due to quadrature. The plot for the output voltage, E_{dc} , as a function of the angular displacement, is shown by Fig. 6. The full scale error due to quadrature, is shown in Eq. 11.

$$\% \epsilon = \frac{100\gamma}{360} = 0.278 \tan^{-1}q, \quad (11)$$

where γ is expressed in radians; $0 \leq q < 1$.

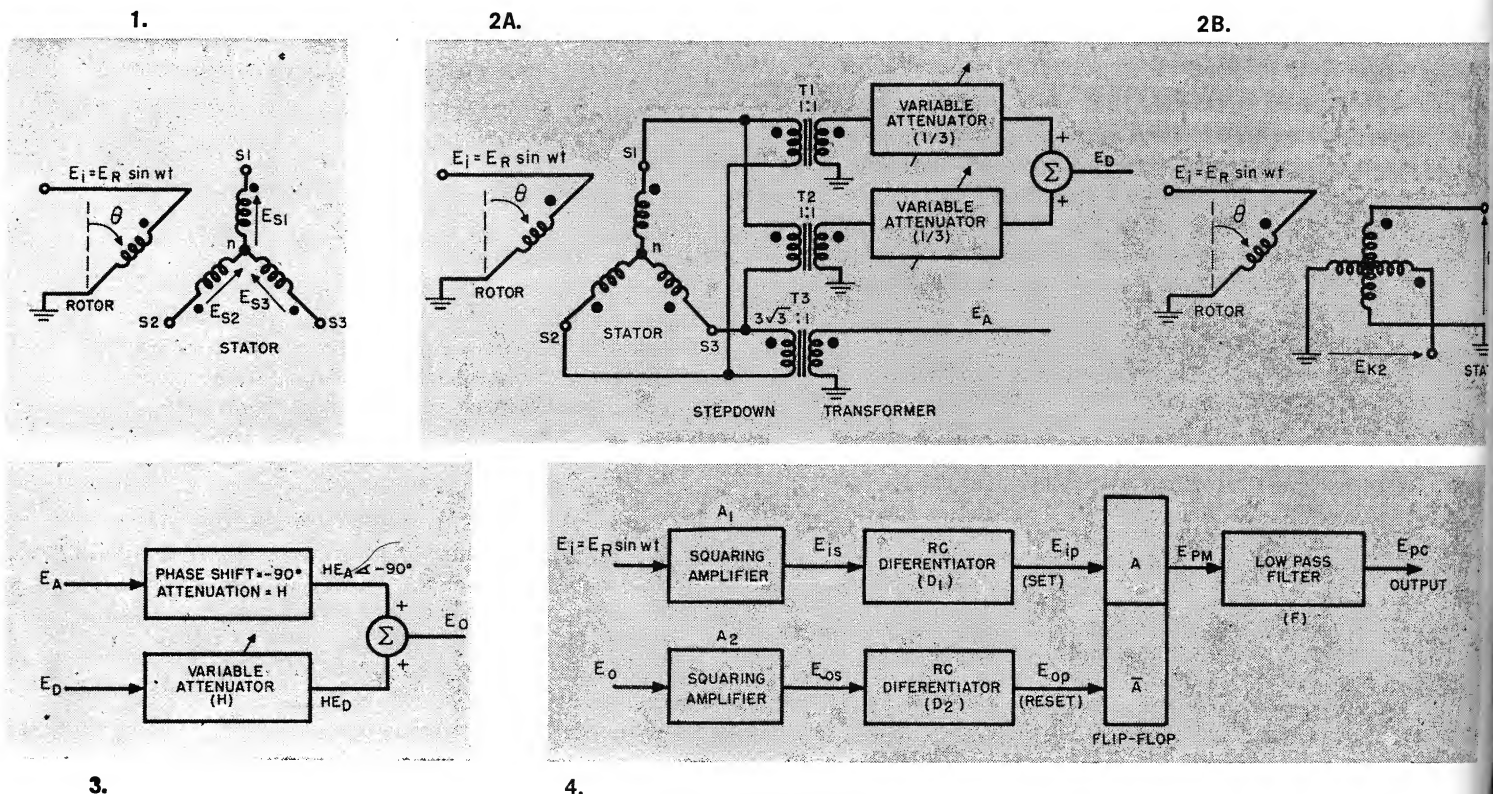


Fig. 1. A synchro rotor, R, excited by an ac voltage of proper magnitude and frequency, produces specific voltages across its stator.

Fig. 2. (A) This configuration of transformers provides a simple means for summing the stator voltages. (B) A simple schematic for a resolver is indicated. Note that

stator has two perpendicular windings.

Fig. 3. Block diagram shows how signals E_A and E_D are combined vectorially.

Fig. 4. The final instrumentation for the dc output voltage versus angular displacement is shown in block form.

Error Analysis of the Converter

The major sources of error in this device are in the transformers, the attenuators, the phase shifting network, and in the effect of quadrature transmission through the entire network. The first two sources of error are shown in Fig. 2A; the last two sources are shown in Fig. 3. These errors are discussed individually and procedures are recommended to minimize their effects.

Errors in Computing Transformers and Attenuators

The components designated in Fig. 2A are assumed to be ideal. However, such factors as input frequency variation, ambient temperature variation and inaccuracies inherent in the manufacture of these components will unavoidably exist. Transformers should not produce any significant phase shift at the frequency of operation. The overall permissible error for phase shift variation is ± 0.1 percent, resulting from frequency variations, manufacturing errors, and ambient temperature variations. The turns ratio of transformers T_1 and T_2 must be very accurate relative to one another. It is not important that the transformation ratio of the transformers be one to one, but the relative error of the turns ratio for these transformers should not be greater than ± 0.1 percent. This can be accomplished via the variable attenuators in the secondaries of transformers T_1 and T_2 . The turns ratio of transformer T_3 is not critical. Its variation may be independently compensated by changing the magnitude of the H attenuator, which does not include the phase shifting network indicated in Fig. 3.

Errors in -90 Deg Phase Shifting Network

To eliminate errors associated with the -90 deg phase shifting network, use the network recommended in Fig. 7. It consists of two low-pass networks separated by an emitter follower. The first low-pass structure shifts the phase of the signal -4 deg, whereas the second low-pass structure shifts the signal phase by -86 deg. This combination provides the desired phase shift of -90 deg while also providing a small tolerable variation in the overall phase shift as a function of input frequency. The transfer function of the network shown in Fig. 7 is indicated by

$$L(j\omega) = \frac{G}{\sqrt{(1 + \omega^2 \tau_1^2)(1 + \omega^2 \tau_2^2)}} \angle (-\tan^{-1} \omega \tau_1 - \tan^{-1} \omega \tau_2);$$

$$\tau_1 = R_1 C_1; \tau_2 = R_2 C_2. \quad (12)$$

G = gain constant of emitter follower.

The gain constant, H , and the -90 deg phase referred to in Fig. 3, are expressed by

$$H = \frac{G}{\sqrt{(1 + \omega_o^2 \tau_1^2)(1 + \omega_o^2 \tau_2^2)}}, \quad (13)$$

where

ω_o = input frequency expressed in rad/sec.

$\phi = -\tan^{-1} \omega_o \tau_1 - \tan^{-1} \omega_o \tau_2$

For small variations of the input frequency, within

the limits of ± 10 percent from nominal, the variations of the gain constant, H , and the phase shift angle, are given by

Gain error =

$$\frac{\Delta H}{H} = \epsilon_H = - \left[\frac{\omega_o^2 \tau_1^2 + \omega_o^2 \tau_2^2 + 2\omega_o^4 \tau_1^2 \tau_2^2}{(1 + \omega_o^2 \tau_1^2)(1 + \omega_o^2 \tau_2^2)} \right] \left[\frac{\Delta \omega}{\omega_o} \right]; \quad (14)$$

Phase error =

$$\Delta \phi = \epsilon_\phi = - \frac{[\omega_o \tau_1 + \omega_o \tau_2] [1 + \omega_o^2 \tau_1 \tau_2]}{[1 + \omega_o^2 \tau_1^2] [1 + \omega_o^2 \tau_2^2]} \left[\frac{\Delta \omega}{\omega_o} \right]; \quad (15)$$

where

$\Delta \omega$ = frequency shift

ω_o = nominal angular frequency

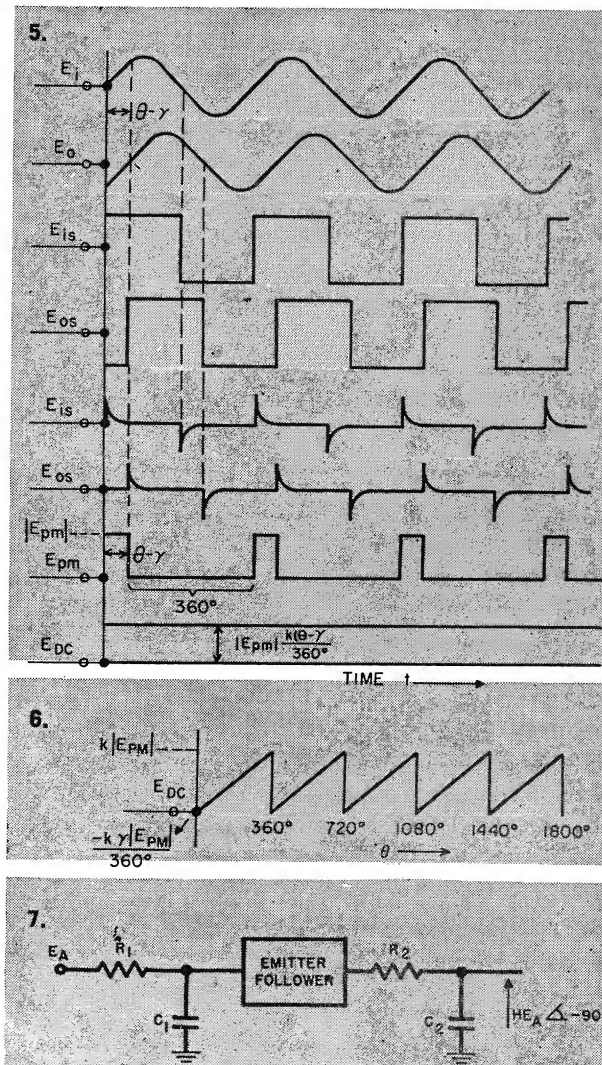
G, H, τ_1, τ_2 = nominal values

Assuming that the operating frequency is 400 cps, and that the frequency variations are within ± 3 percent of the nominal frequency, we get the following results for ϵ_H and ϵ_ϕ : $\epsilon_\phi = 0.0042$ radians; $\epsilon_H = 0.03$

Fig. 5. Waveshapes for the system of Fig. 4.

Fig. 6. Plot for the output voltage, E_{dc} , as a function of angular displacement.

Fig. 7. Simple -90 deg phase shifting network can be accomplished by an RC capacitor arrangement coupled to an emitter follower.



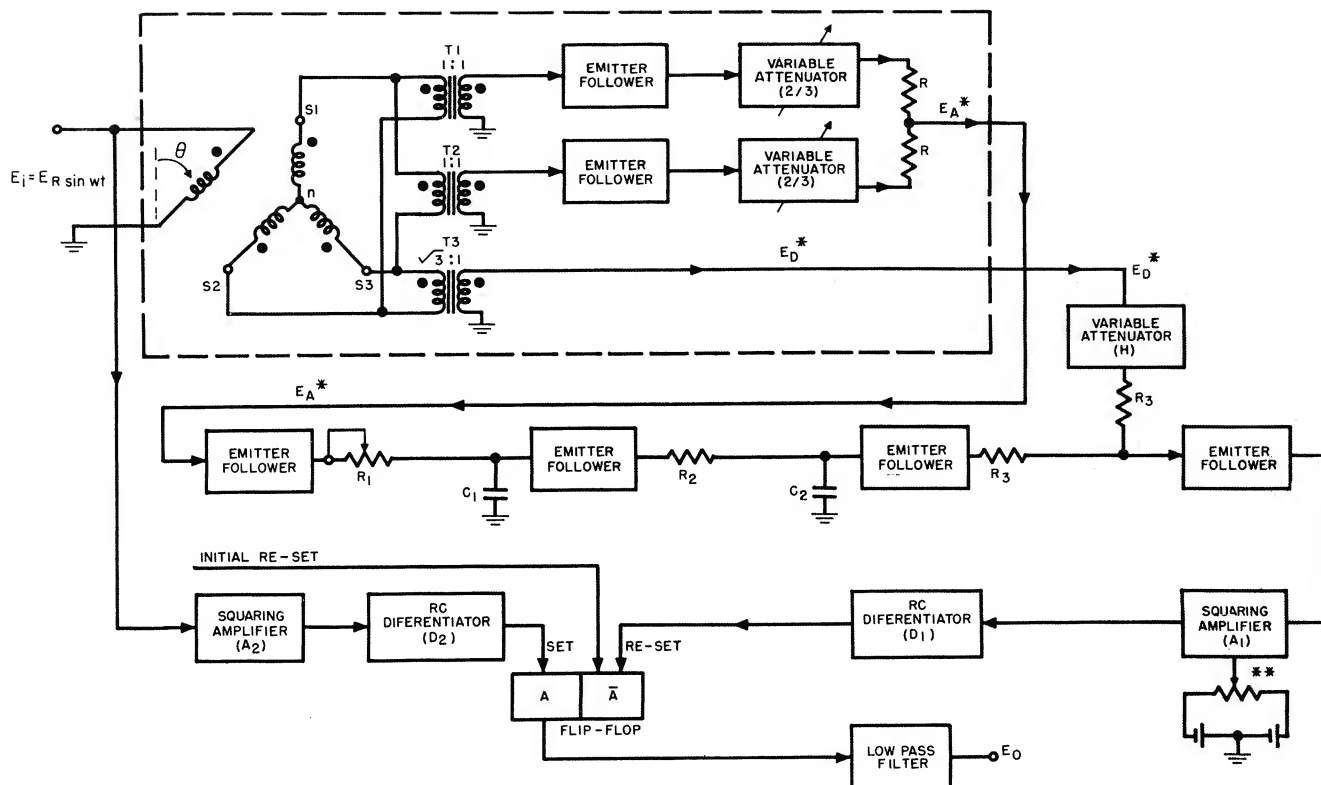


Fig. 8. Complete system for converting angular displacement to dc voltage.

radians. The nominal values of $\omega_0\tau_1$ and $\omega_0\tau_2$ are such as to produce phase shifts of -4 and -86 deg, respectively, resulting in values of $\omega_0\tau_1 = 0.07$ and $\omega_0\tau_2 = 14.5$.

Modifying Eq. 9 to include the effects of the gain and shift variations, yields

$$E_o \cong H E_R \sqrt{1 + q^2} \left[\sin(\omega t - \theta + \gamma) - 0.03 \sin \theta \cos[\omega t + \gamma] \right]; \quad (16)$$

where $\gamma = \tan^{-1}q$; $\sin \epsilon_\phi \cong \epsilon_\phi$; $\cos \epsilon_\phi \cong 1 - \frac{\epsilon_\phi^2}{2}$; ϵ_ϕ is small.

The second term in Eq. 16 represents the error introduced into the output voltage, E_o . The effect that this error has upon the zero crossings of the signal is to shift them from their ideal location. The error is a function of the angle, θ , and assumes its maximum magnitude when θ equals odd multiples of 90 deg. The maximum magnitude of the error at the zero crossover point is 0.03 radians. This represents 0.478 percent error when referred to full scale of 360 deg.

Quadrature Transmission Errors

The quadrature voltage introduced at the synchro and resolver causes a displacement error in the resulting dc output voltage. If the quadrature insertion into this device is constant for all angular displacements, the output is merely shifted from its theoretical value by a constant amount. This represents a static condition and can be compensated by either a dc bias voltage at the output, or by adjusting the zero cross-

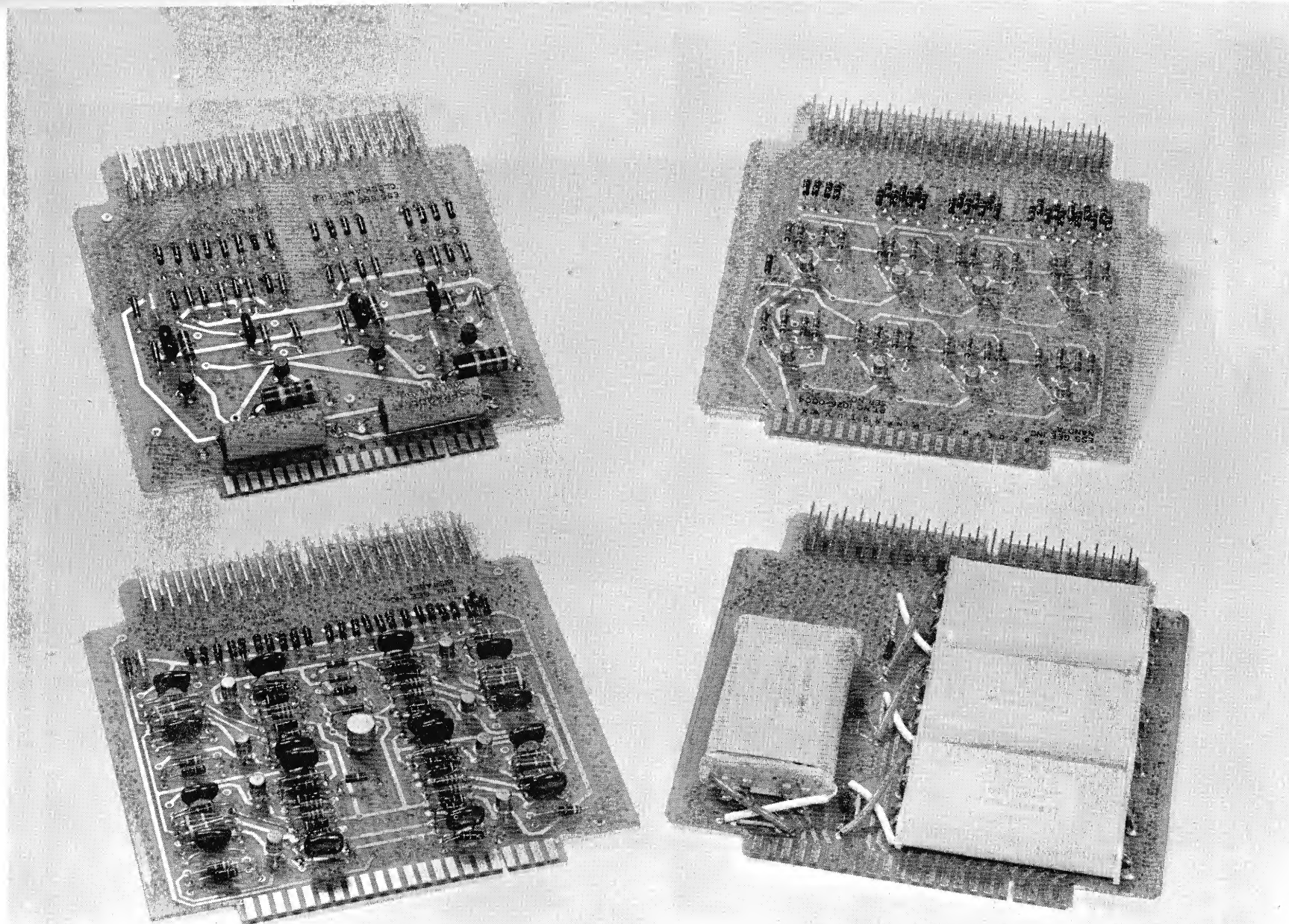
over detection point of the squaring amplifier, A_1 , shown in Fig. 8. If the quadrature insertion varies as a function of the angular displacement, a dynamic variation in the output dc voltage will result. For this case, the output may be compensated so that the quadrature error may be divided in half. The error effect of quadrature is illustrated in Fig. 6 by the quantity $k|E_{pm}|\gamma/360^\circ$. In practical cases, care should be used in choosing synchros and resolvers so that a minimum amount of quadrature exists for these components.

The device presented in this article offers a means of converting angular displacements to dc voltages without the use of servos. Errors are inherent in the instrumentation, and care must be taken in choosing components that contribute minimum errors to the overall desired output. Within the present state of the art, a device of this type can be reliably designed to produce errors no greater than ± 0.7 percent of full scale. This error may be further reduced by a different choice of a quadrature phase-shifting network. It is felt, however, that the type of network suggested affords significant simplicity and accuracy. The composite of the circuitry, indicated by Fig. 8, indicates the manner in which various functions and controls may be combined to afford simplicity. Note that the circuitry shown in Fig. 8 is identical for synchro or resolver operation, wherever noted.

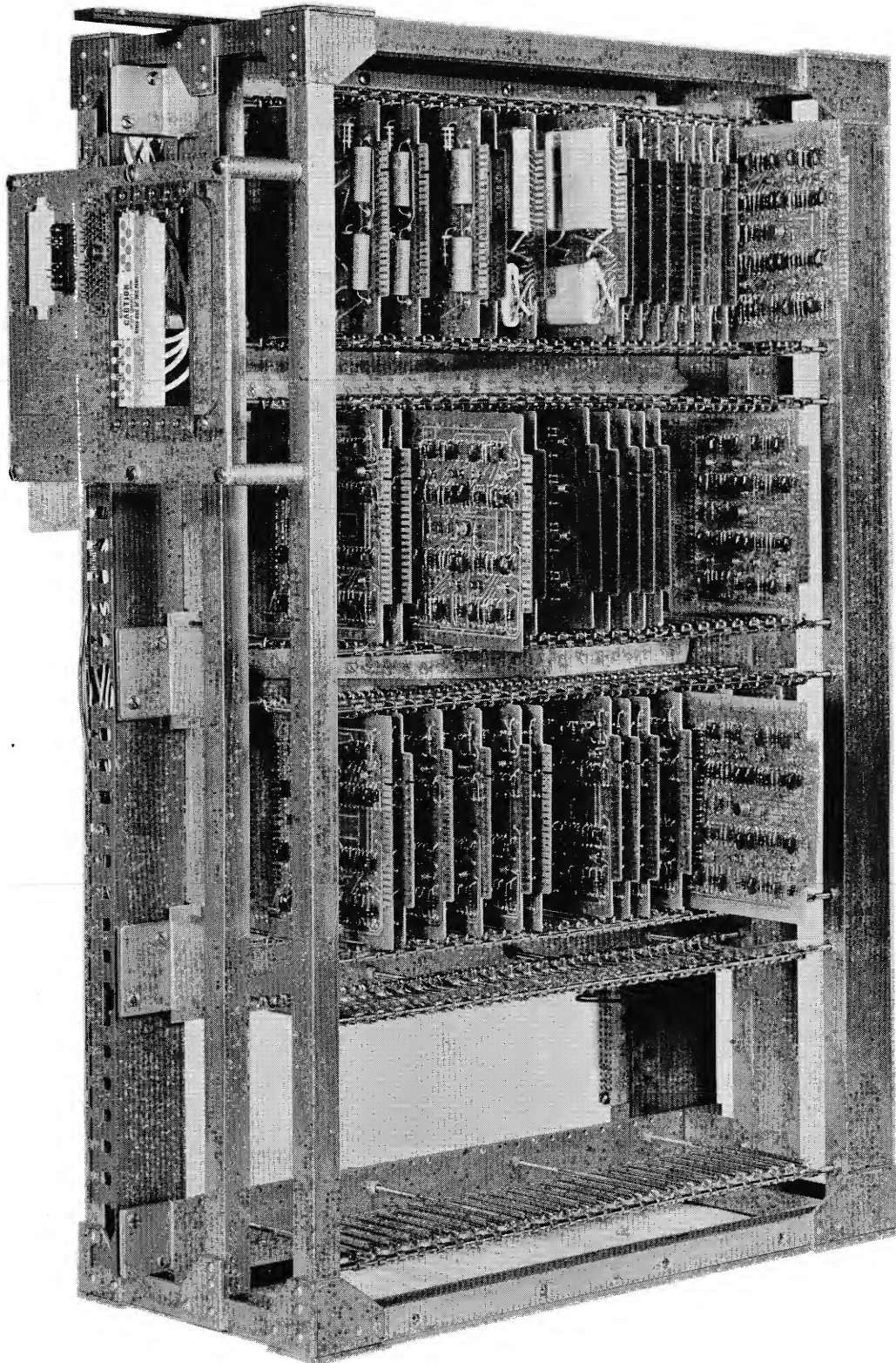
EEE

References

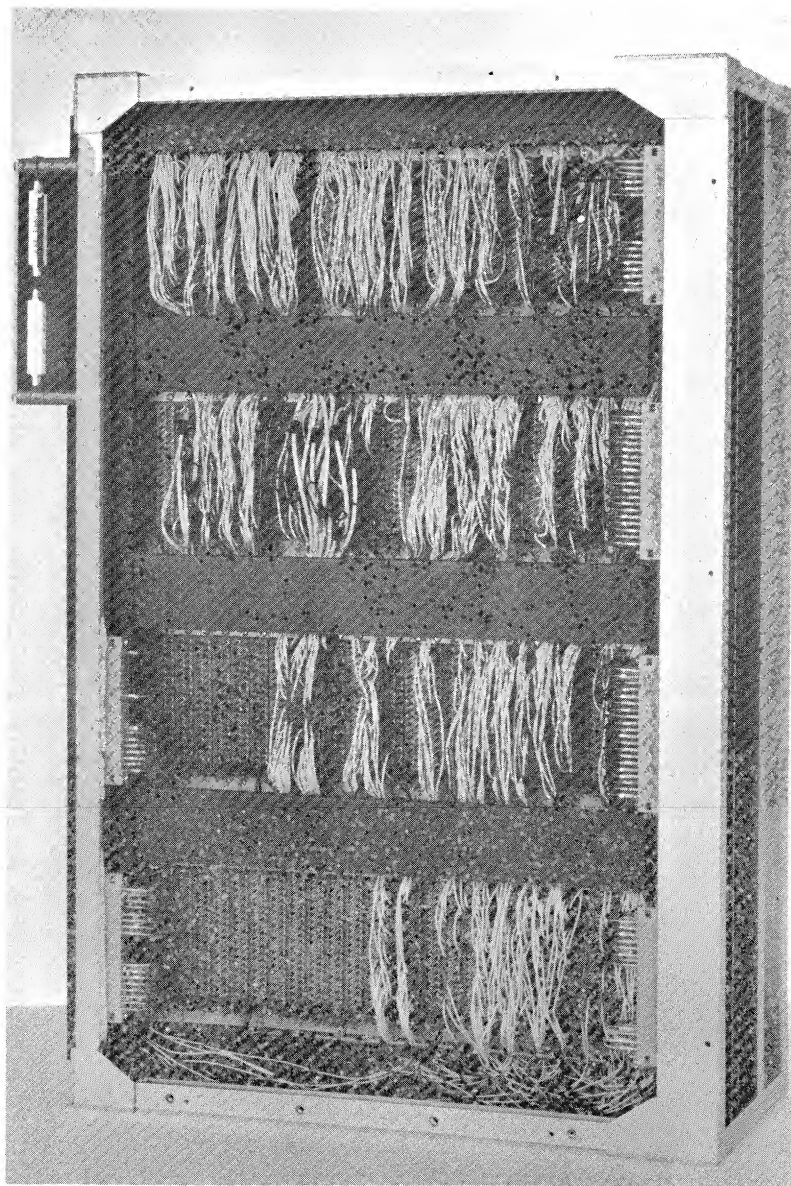
1. Lauer, Lesnick, Matson, "Servomechanism Fundamentals," McGraw Hill Book Company, New York, N. Y., 1960.
2. Savant, "Basic Feedback Control System Design," McGraw Hill Book Company, New York, N. Y., 1958.



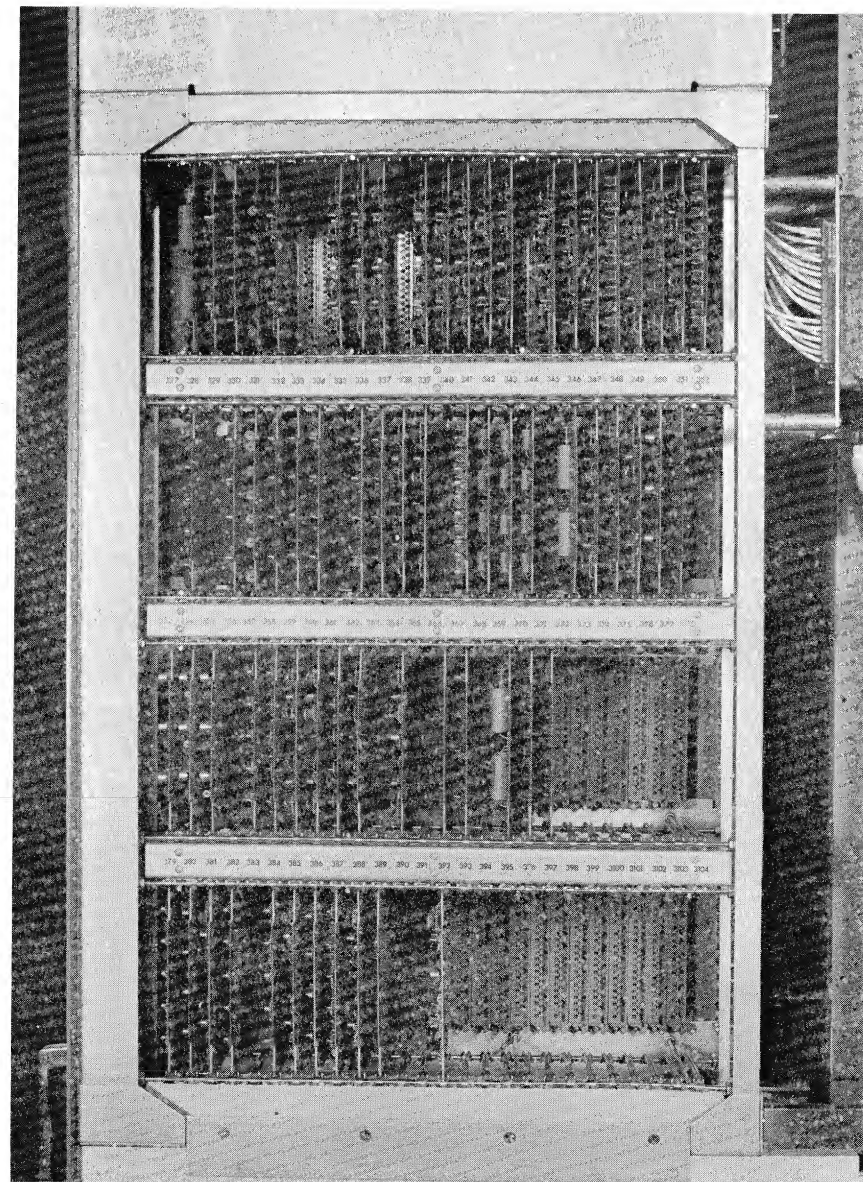
RELIABLE SOLID-STATE PRINTED CIRCUITS FORM
THE BASIC BUILDING BLOCKS FOR ESS GEE'S DIGITAL SYSTEMS



DRAWER ASSEMBLY SHOWING ACCESSIBILITY OF TEST POINT CONTACTS ON
INSTALLED LOGIC CARDS. ALL ESS GEE LOGIC CARDS ARE
DESIGNED WITH THIS SPECIAL TEST FEATURE



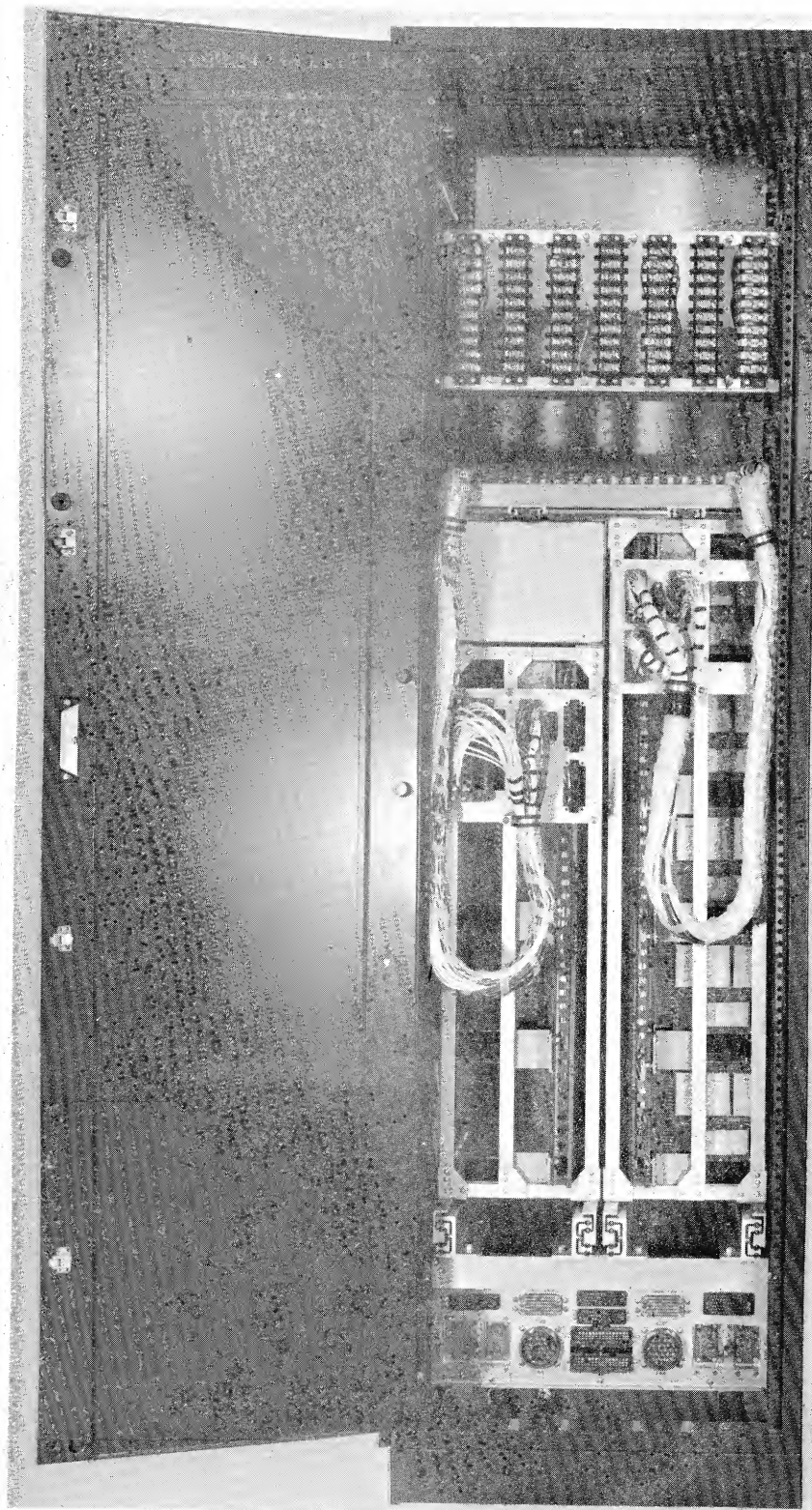
REAR VIEW OF DRAWER ASSEMBLY SHOWING TAPER
PIN WIRING TO CARD CONNECTOR RECEPTACLES
AND TERMINAL BLOCKS



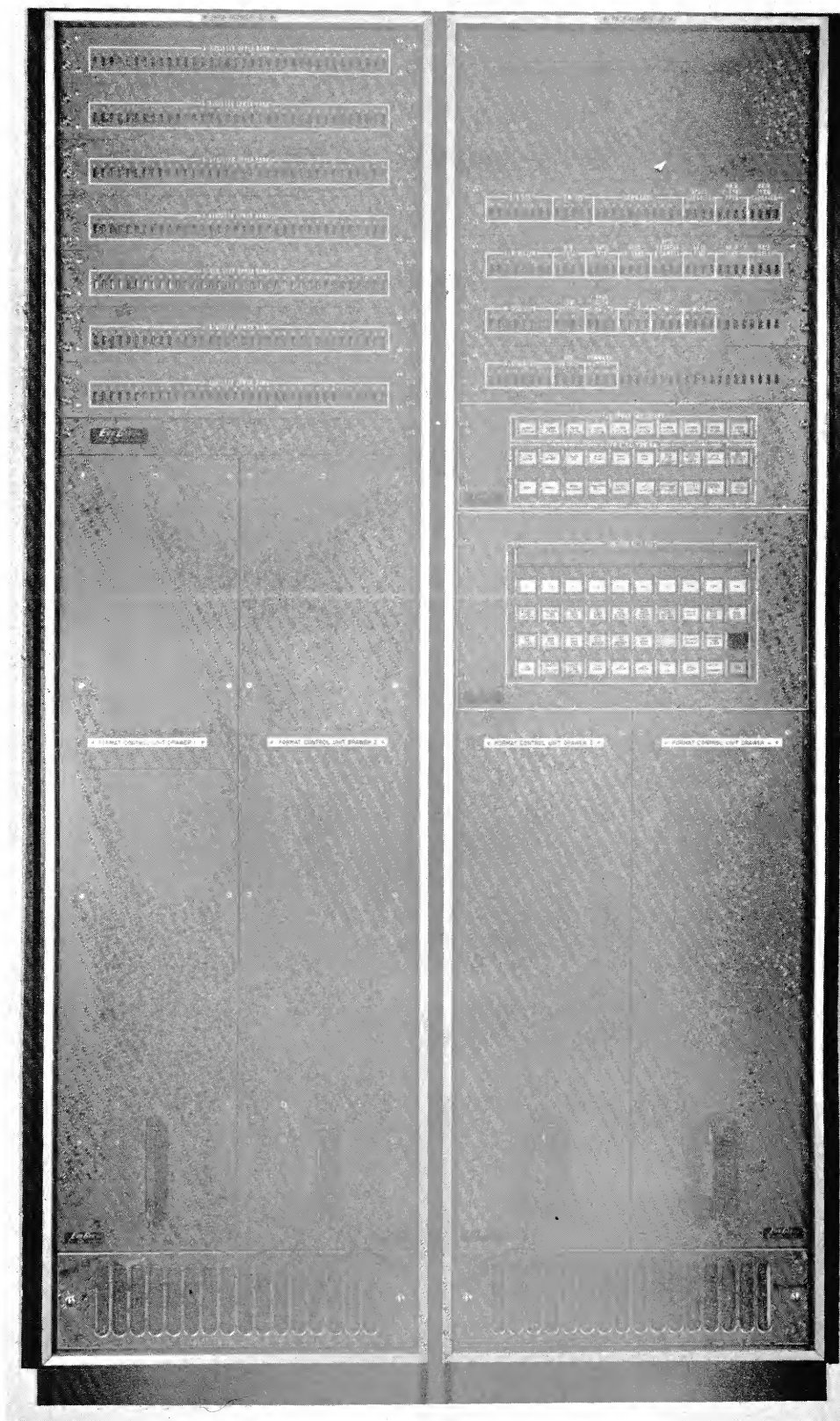
FRONT VIEW OF COMPLETED DRAWER ASSEMBLY



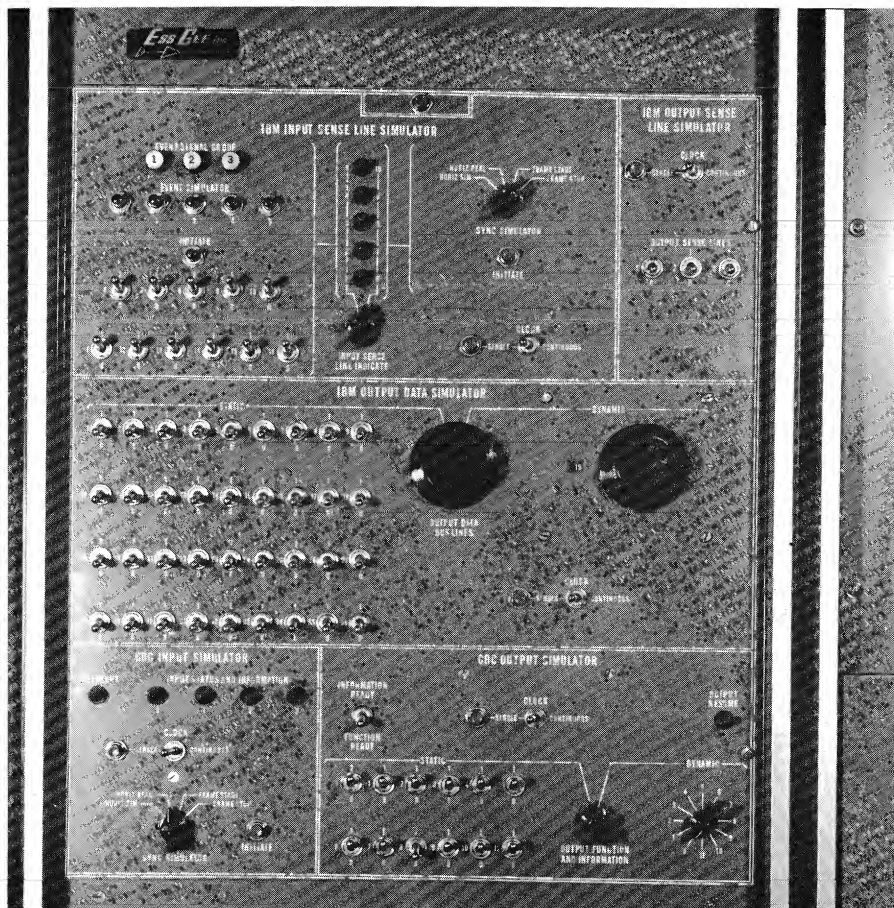
SLIDING RACK AND DRAWER ASSEMBLY DESIGNED AND BUILT BY ESS GEE, INC.
DESIGN PROVIDES ACCESS TO EITHER SIDE FOR EASE OF MAINTENANCE



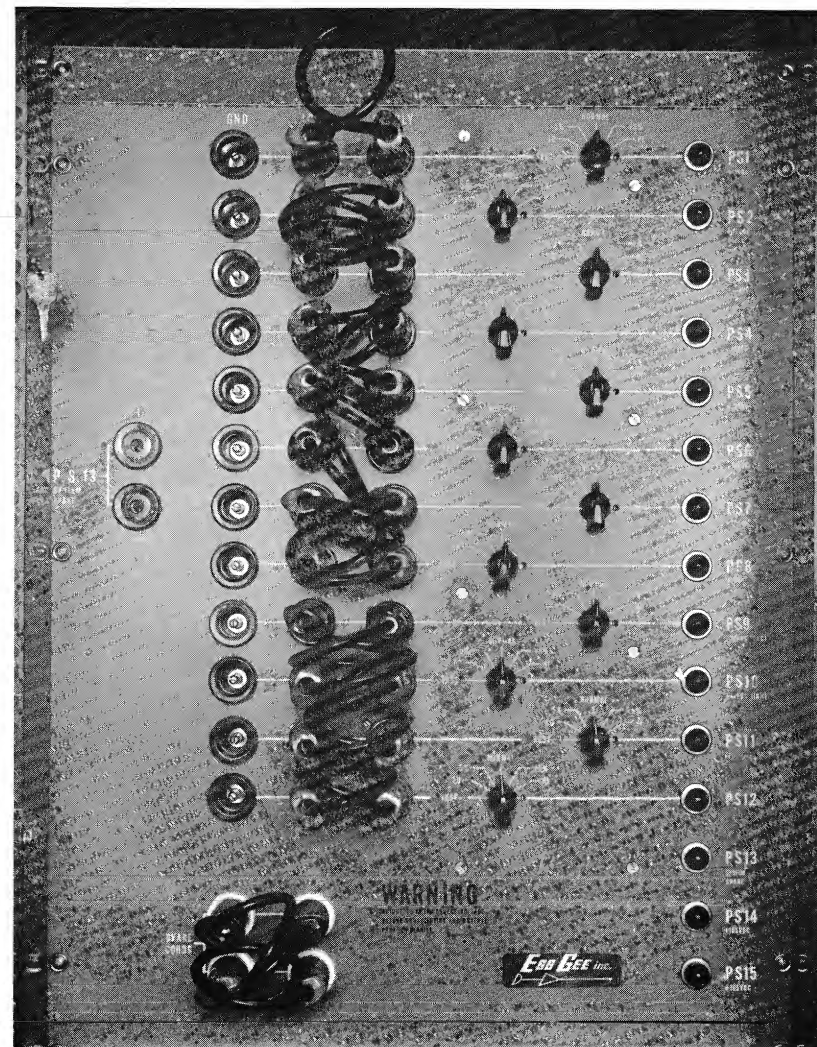
REAR INTERNAL VIEW OF EQUIPMENT RACK WITH TWO SLIDE-OUT DRAWERS
INSTALLED AND ELECTRICALLY CONNECTED



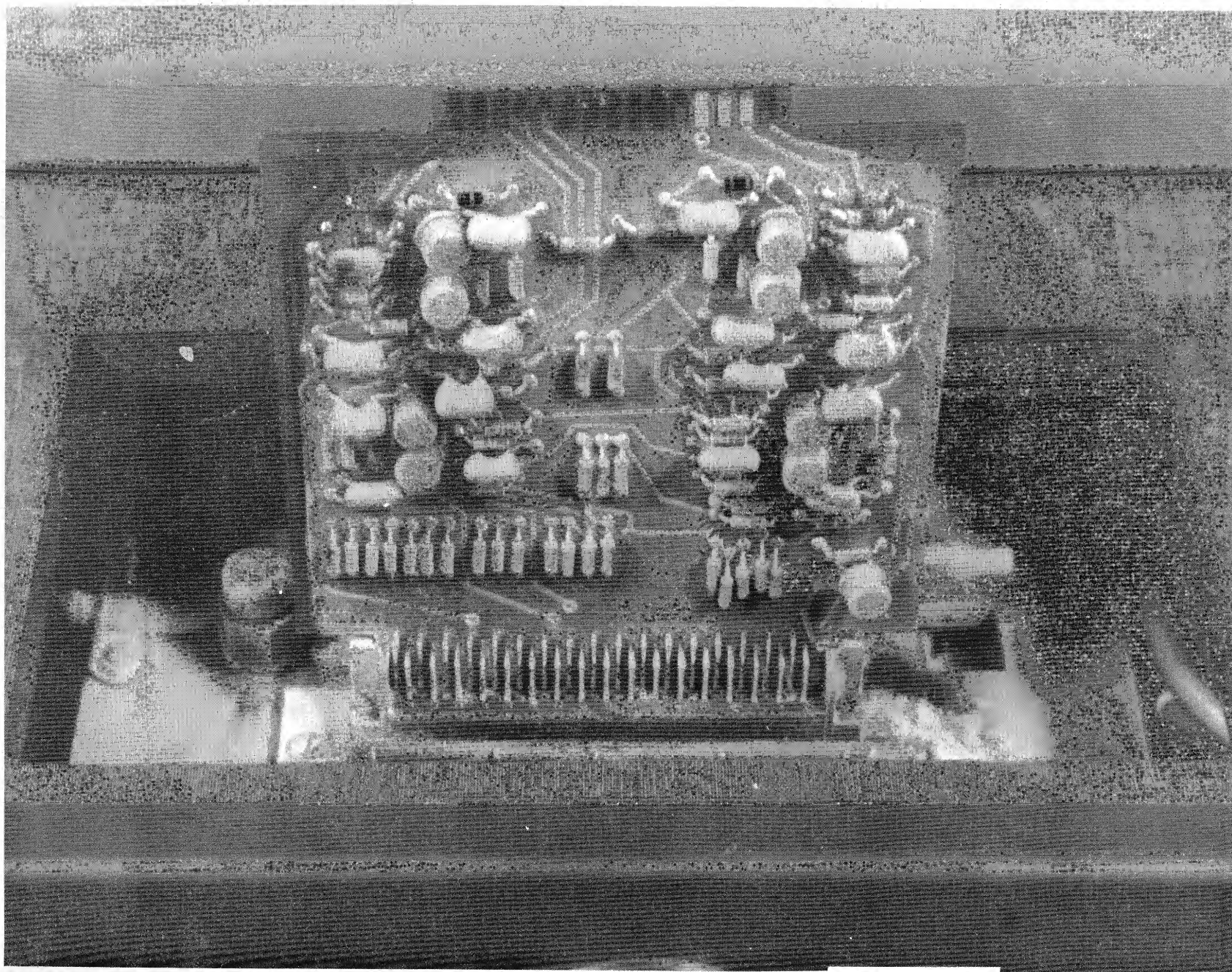
FRONT VIEW OF DUAL EQUIPMENT RACK CONTAINING FOUR LOGIC DRAWERS,
INDICATOR PANELS, AND TEST CONTROLS



CONTROL PANEL ASSEMBLY FOR COMPUTER
SIMULATION (IBM 7094)



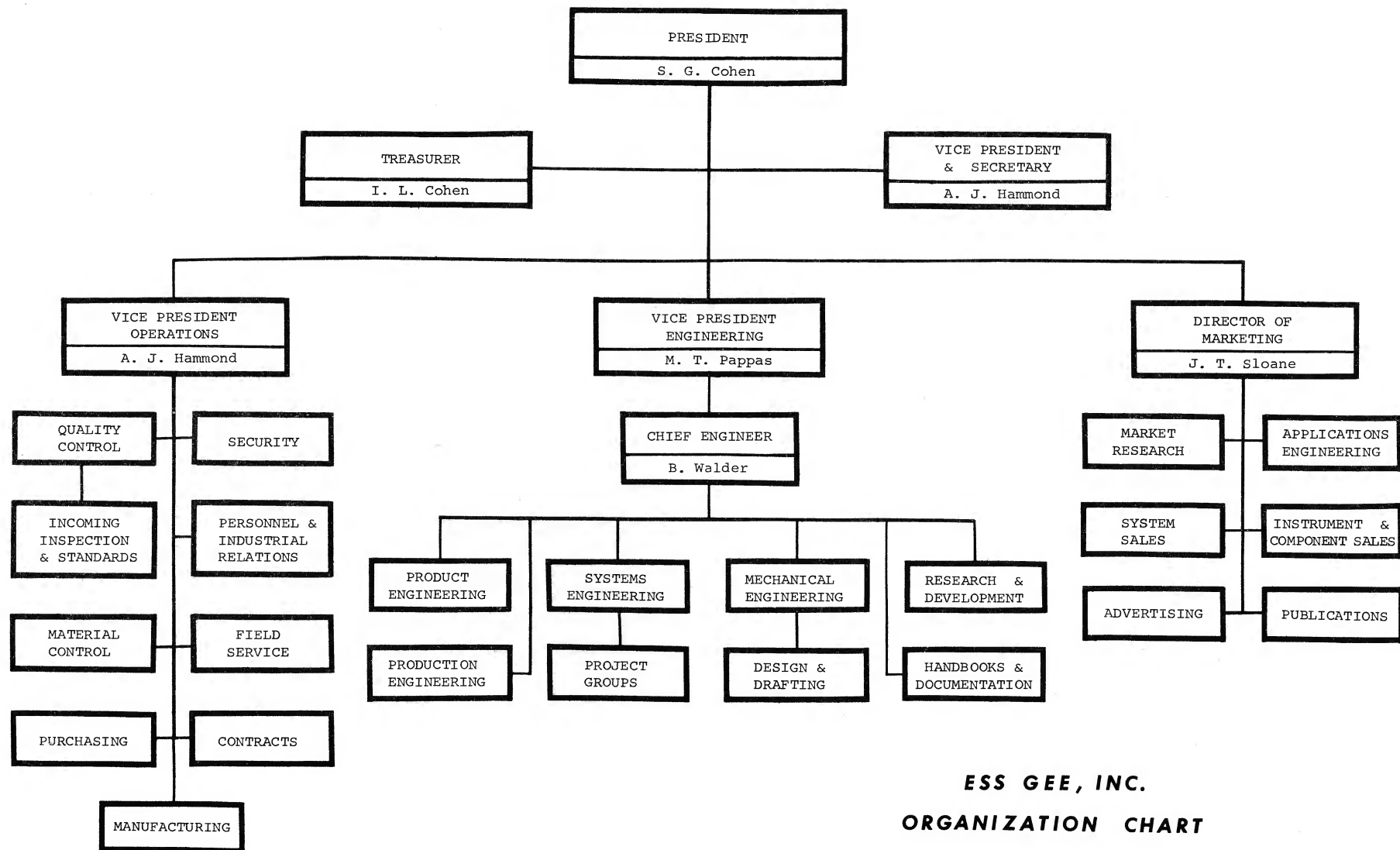
SYSTEM POWER PATCH PANEL ASSEMBLY WITH
MARGINAL VOLTAGE CONTROLS



Logic Card Undergoing Environmental Cold Test

ESS GEE, Inc.
White Plains, N.Y.

BIOGRAPHIES
OF
KEY PERSONNEL



ESS GEE, INC.
ORGANIZATION CHART

SAMUEL G. COHEN

PRESIDENT

EDUCATION

Mr. Cohen has received Bachelor Degrees in Aeronautical Engineering and in Electrical Engineering from Rensselaer Polytechnic Institute in 1946 and 1948, respectively. In addition, Mr. Cohen has completed graduate studies in Electronics at Brooklyn Polytechnic Institute. While in military service, he attended U. S. Navy Flight Training, Instrument Instructors and Celestial Navigation courses. Mr. Cohen also holds a Commercial Pilot's License with an instructor's rating for single or multi-engine land aircraft.

EXPERIENCE

Mr. Cohen was associated with the Sperry Gyroscope Company from 1948 to 1951 as a Systems Engineer. In this position he had direction of a group concerned with the development of remote flight control systems and of groups concerned with the QF-80 and B-47 Brass Ring Projects.

At Grumman Aircraft Corporation, Mr. Cohen was a Missile Autopilot Test Engineer, responsible for the complete testing and analysis of hydraulic servomechanisms for missiles, and instrumentation development for missiles and aircraft. He also had responsibility for the combined aerodynamic-servo interaction study program of the tail-buffeting problems in the F9F-6 airframe in connection with the hydraulic flying tail. Development of specialized instrumentation and recording systems for both missile and aircraft usage became a specialty.

From 1953 to 1958, Mr. Cohen was associated with General Precision Laboratory, Inc, as a section head at the Westchester County Airport. His primary responsibilities as director of the Flight Instrumentation Section included the administrative and technical aspects of Doppler Flight Test instrumentation, photogrammetric ground grid surveys, high-accuracy photography, precision servos, and analog-digital converters. He also had responsibility for the design, fabrication, and testing of three meteorological digital data recording systems in B-50 and B-47 aircraft for the National Hurricane Research Project of the U. S. Weather Bureau and for the design of a magnetic tape recording system, compatible with IBM 704, for B-47 aircraft for Lockheed Aircraft Corporation.

ESS GEE, Inc.

S. G. Cohen (cont'd)

Late in 1958, Mr. Cohen was named director of the Data Processor and Test Equipment Section at General Precision Laboratory, Inc, in conjunction with the ATC Data Processing Central System. In this capacity, he directed the coordination of the design, fabrication, and test of the ATC Data Processor System, In addition, Mr. Cohen was responsible for the design and modification of special test equipment for ATCDP.

In July of 1960, Mr. Cohen created ESS GEE, Inc, and began the design, development, and fabrication of an airborne magnetic tape recording system for the U. S. Weather Bureau. In his present position, he serves as Company President and Engineering Consultant.

Mr. Cohen is a member of the AIEE, I.A.E.S., and ISA. He holds five patents in the field of digital instrumentation. His publications include "Automatic Digital Recording of Flight Test Data," AIEE, January 1956; and "Digital Airborne Tape Recording," WESCO IRE, August 1958.

MICHAEL T. PAPPAS

VICE PRESIDENT OF ENGINEERING

Education

M of E.E. degree, New York University, 1961

B of E.E. degree, Cooper Union, 1949

Various additional graduate level courses in Physics, Mechanics, and Mathematics

Experience

May 1962 to Present - ESS GEE, Inc.

Mr. Pappas joined ESS GEE, Inc, in May 1962 as Systems Engineering Director. In this capacity his primary responsibility was the management of the company's NIMBUS System Program. His tasks also include planning and marketing efforts, and direction of all system engineering efforts.

1958 to 1962 - GPL Division - General Precision, Inc, Pleasantville, New York, Associate Section Head, Systems Department

His responsibilities at GPL included leadership of proposal and advanced development teams in design, evaluation, and analysis of systems, generation of proposals and presentations, and engineering support to company sales efforts.

These tasks were in the general fields of inertial and doppler navigation, data processing, display equipment and techniques; they included design and evaluation of complex systems, with attendant feasibility, stability, and error analysis.

This work involved customer contact to develop operational requirements, reduction of these to system functional requirements, and finally generation of equipment specifications.

Mr. Pappas contributed to the design of various GPL proprietary items in the data collection and handling field.

1956 to 1958 - Philips Electronics, Mount Vernon, New York, Electronic Design Group Head

ESS GEE, Inc.

Michael T. Pappas (cont'd)

Here he designed a complete electronic system for use with x-ray spectroscopy and fluoroscopy, including sensors, amplifiers, batching and counting circuitry, and all electronic control circuits.

He also supervised a group of engineers and technicians in breadboard, prototype construction, and final production design.

1955 to 1956 - RCA, Camden, New Jersey, Senior Electronic Engineer

At RCA he designed and packaged subminiaturized, solid-state servo amplifiers. He instituted many "quick-fixes" on the MA-10 fire control equipment.

1951 to 1955 - General Precision Laboratory Incorporated, Pleasantville, New York, Staff Member

Designed major subassemblies or radar system including synchronizer, deflection circuitry, and high-voltage power supplies. Also engaged in a wide range of circuit design work in tubes and transistors.

1949 to 1951 - Allan B. Dumont Labs, East Paterson, New Jersey
Electronic Engineer

TV receiver and transmitter circuit design and test. Receiver component evaluation and quality control work.

Societies

Institute of Radio Engineers and The American Rocket Society.

ANDREW R. COHEN

Senior Scientist

Education

B. S. in Electrical Engineering, 1957, Massachusetts Institute of Technology
M. S. in Electrical Engineering, 1958, Massachusetts Institute of Technology
Doctor of Philosophy, 1961, Purdue University

Experience

1962 - ESS GEE, Inc, Elmsford, New York

Dr. Cohen is a senior member of the Electronics Design Group and a participant in ESS GEE's Project Review Board. His duties involve the design and development of beyond-the-state-of-art techniques in solid-state circuitry and application. His experience in tolerance analysis and other qualitative design measures adds much depth to the Electronics Design Group.

1961 to present - Assistant Professor of Electrical Engineering, New York University, New York City

Mr. Cohen is also presently teaching graduate level courses in the area of noise and random processes. He is also engaged in research in the area of pattern recognition including efficient encoding techniques for geometrical data and automatic recognition of handwritten characters.

1958 to 1961 - Instructor in Electrical Engineering, Purdue University, Lafayette, Indiana

Taught courses in circuit theory and electronics. Doctoral research on the problem of the calculation of the first-order probability distribution functions of the outputs of linear systems for random square-wave inputs.

June 1959 to September 1959 - Research Engineer, Research Division, Melpar, Incorporated, Watertown, Massachusetts

Tasks included development of a dynamic model for ground-to-air

ESS GEE, Inc.

Mr. Andrew R. Cohen (cont'd)

interference based on statistical considerations.

1957 to 1958 - Research Assistant, Instrumentation Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Duties included analytical and experimental feasibility studies, logical design, and circuit design for a digital accelerometer system under the Polaris program.

Professional Societies

Member, Institute of Radio Engineers

Honary Societies

Member, Society of Sigma Xi

Member, Eta Kappa Nu

BURTON WALDER

CHIEF ENGINEER

Education

New York University, BEE 1947
New York University, MEE 1949
Polytechnic Institute of Brroklyn, Graduate Courses, 1960-1961

Experience

ESS GEE, Inc.
July 1962 to present

Chief Engineer

Mr. Walder is the director in charge of the Systems Engineering Group. He is responsible for the supervision and coordination of all system analysis and design. His current assignments include that of Assistant Project Manager for the NIMBUS Data Reduction System for the Weather Bureau's Meteorological Satellite Activity. His work includes the preparation of proposals, estimates, and schedules.

GPL Division - General Precision, Inc.
1959 to 1962
Senior Staff Member

Mr. Walder was technical supervisor and senior engineer responsible for the system analysis, logic, and circuit design of a special purpose printer and handling mechanism to be used as an on-line computer output device.

He had project responsibility for the system analysis, and design of a business computer using delay lines for the memory elements. This included the investigation and development of magnetostrictive delay lines and associated circuitry as well as the analysis of the system, logic, and circuit requirements.

He had also been engaged in the logic and special circuit design of several devices for the FAA ATC system.

American Machine and Foundry Co.
1958 to 1959 - Group Leader

Mr. Walder was responsible for the requirement analysis, design, and fabrication of the instrumentation system for the prototype Titan Hard-Base Launcher. His other assignments included a variety of special instrumentation projects.

Production Research Corporation
1952 to 1958 - Project Engineer

This position involved research and development project responsibilities on a variety of classified Government contracts. Technical fields involved were R.F. and microwave antennas and devices, magnetic recording, control equipment, and countermeasure systems.

Veterans Administration
1949 to 1952 - Electronic Scientist

He was engaged in research development, analysis and test of prosthetic devices and sensory aids.

New York University
1947 to 1949

This position involved the development of a high speed, repetitive ballistic camera. He was later Instructor in Electrical Engineering in the College of Engineering.

Registration

Professional Engineer #34224, New York State

Honor Societies

Tau Beta Pi
Eta Kappa Nu

Professional Society

Member, Institute of Radio Engineers

Military Service

USNR, Active Duty - May 1944 to July 1946
USNR, Inactive - July 1946 to September 1955
Honorably Discharged with rank of Lt (j.g.)

EUGENE R. KEELERDIRECTOR OF APPLIED
RESEARCH AND DEVELOPMENTEducation

B of EE Degree - New York University - 1961

Experience

Prior to his affiliation with ESS GEE, Inc, Mr. Keeler had been associated with Loral Electronics Corporation as a Senior Engineer from 1961 to 1963.

In this capacity, he directed the design and fabrication of microminiaturized analog and digital systems for aerospace applications. Representative of his efforts in this field are a multi-channel radiation pulse height analyzer, a parallel analog-to-digital converter, and a 10-cubic-inch data processing device, utilizing state-of-the-art molecular electronics, with a magnetic core memory system.

During the period between 1960 and 1961, Mr. Keeler was associated with Power Designs, Inc, of Westbury, New York, where he was coordinator of power supply system activities; and was responsible for the design of control systems and power supply circuitry.

From 1958 to 1960, as an Associate Staff Member at General Precision Laboratory, he engaged in the design and development of circuitry for an Air Traffic Control System. Specific duties included the design of transistor switching circuits, input devices, a digital-to-analog converter, and responsibility for the purchase and design of the system power supply.

With Bell Telephone Laboratories, New York, from 1955 to 1958, Mr. Keeler designed transistorized telephone switching circuitry and central office facilities Personal Radio Signaling.

Mr. Keeler holds three patents in the data processing field.



WALTER KOTZEProject ManagerEducation

Mr. Kotze has studied electrical engineering at Pratt Institute and electronics engineering at Westchester Community College. As a part of his military training, he attended the U. S. Army Signal Corps Radio School.

Experience

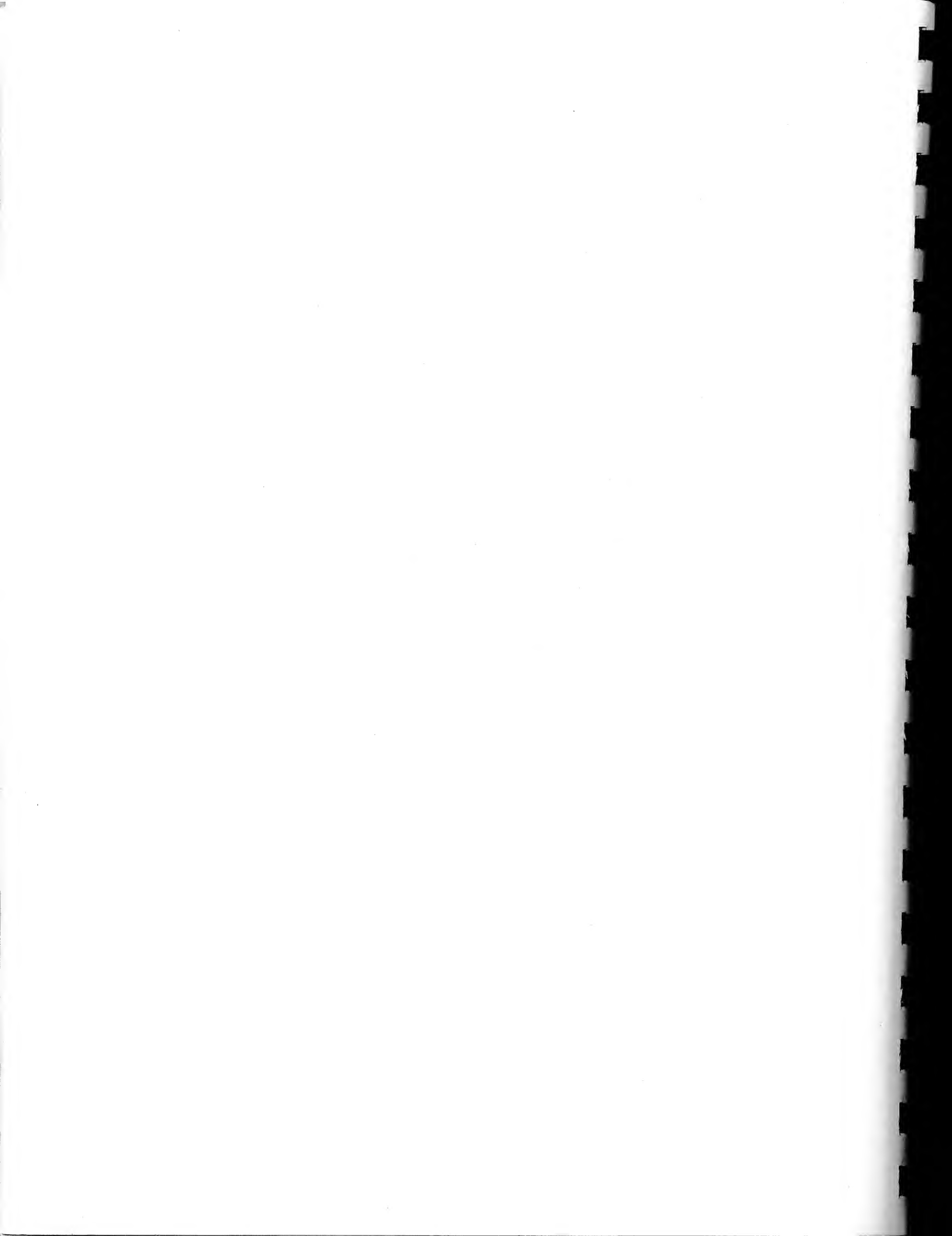
In 1945, prior to entering college, Mr. Kotze was employed as an engineering assistant with the Quality Control and Testing Department of Alexander Electronics, Inc. In this position he was responsible for the inspection and testing of electronic equipment. Mr. Kotze developed a unique production line test procedure which enabled inexperienced employees to perform line tests.

During his school years, Mr. Kotze was employed as a service technician and repairman on entertainment-type electronic equipment.

In 1953 Mr. Kotze joined the engineering staff of General Precision Laboratory, Inc, and was assigned to the Instrumentation Section of the Flight Test Department. He assisted in the development of an instrumentation system employing IBM equipment as the primary data recorder device. His design work included a digital recording system using servo-controlled analog-digital converters as data sensing elements for IBM machines.

Mr. Kotze was assigned to the Data Processor and Test Equipment Section at General Precision Laboratory, Inc, in 1959. In this assignment he had the primary responsibility for the development and test of an FAA Peripheral Sector Console Tester. Other assignments in this position included the primary responsibilities concerned with the design, development, and fabrication of the Peripheral Equipment Tester and other items of special FAA test equipment.

In July 1960, Mr. Kotze accepted his present position as Program Manager at ESS GEE, Inc. In this capacity he reports directly to the Chief Engineer and is responsible for the technical direction of specialized projects.



HERB CUNITZProject EngineerEducation

BEE Degree - Clarkson College of Technology
Graduate Studies - Brooklyn Polytechnic Institute

Experience

General Precision Labs - Three years System Engineering

Research and development of Estimated Time of Arrival Computer including all phases of the servo analog computer and flight testing. Developed angle of Pitch, angle of yaw flight attitude computer using gyro pick offs. Gained experience in calibration of electro-mechanical apparatus and extensive environmental testing. Systems design work on paper tape recorder for U. S. Navy Underwater Sound Laboratory Oceanographic Information Program including design, solid-state circuit layout, fabrication and testing. As project engineer designed and developed Octal code punched card instrumentation system for flight test research programs. Designed magnetic core logic for airborne magnetic tape recorder. Developed automatic dynamic logic card checker and computer simulator for FAA Airmodernization Board program also redesigned many circuits for Supervisor's Console.

ESS GEE, Inc. - Two years Project Engineer

Complete responsibility for all aspects of U. S. Weather Bureau Airborne Digital Instrumentation System. Performed evaluation study of digital system requirements. Field service and customer liaison. Implemented Gust Probe location study and coordinated manufacture of Gust Probe with sub-contractor.

Project engineer for the Gust Probe system for the U. S. Weather Bureau. This system (solid-state) provides the excitation, amplification and demodulation for three pressure transducers and two accelerometers in a Giannini Gust Probe. The accelerometer outputs are integrated and all five parameters are then multiplexed into a 4000 conversion/sec., three digit, A/D Converter; the output of which is recorded on the U. S. Weather Bureau digital tape system. Responsibility for the design of the A/D Converter including operational and integrating amplifiers and specialized circuitry.

Project engineer for the design and development of a two digit solid-state A/D Converter with a maximum sampling rate of 200 conversion/sec. Responsible for the design of all circuitry including operational

ESS GEE, Inc.

Herb Cunitz (cont'd)

amplifiers and sample and hold circuits.

Project engineer for a system to instrument two drone aircraft and a DC-6 to gather information in severe storm weather missions for the U. S. Weather Bureau. Information measured by four transducers is amplified, converted to four telemetry channels and transmitted by FM radio to a DC-6 aircraft where the four frequencies are measured and recorded on the digital tape system. Design of the solid-state DC amplifiers to operate in the wing tip pods of the drone.

ALAN WACHTEL

Senior Staff Engineer

Education

Graduate work toward M.E.E., City College of New York, 1961 to Date
(course completed in advanced mathematics, statistical theory
of communications, communications system analysis and synthesis,
logic design, and digital computers)

B.E.E., City College of New York, 1959

U. S. Army Engineer Officers' Basic School, Ft. Belvoir, Virginia,
1959

U. S. Army Guided Missile School, Ft. Bliss, Texas, 1959, (NIKE-
AJAX, NIKE_HERCULES, and HAWK)

Honors

ETA KAPPA NU, Electrical Engineering Honor Society

Armed Forces Communications and Electronics Award, 1959

Scholastic Achievement Wreath, 1958 and 1959

Alexander Hamilton Post Medal, 1956

New York State Scholarship

Experience

1961 to Date - ESS GEE, Inc.

Senior Staff Engineer

Engaged in system design and specification of ground data handling and conversion system for NIMBUS Weather Satellite program. This included: Analysis of microwave and landline communications systems including performance and trade-off studies; System synthesis, optimixation, and integration; Comparative modulation analyses; Data compression studies; Comparative analysis of digital computers for real time scientific data processing.

Generated proposals and delivered technical presentations in support of company activities. Served as customer liason man to develop customer requirements into functional system plans, and generated equipment specifications.

Directed NIMBUS subcontract engineering effort involving industry surveys, specification generation, and engineering liaison with all system subcontractors to the program.

1959 to 1961 - GPL Division, General Precision Inc, Pleasantville,
New York

Associate Staff Member

Project engineer and logic designer of a high-speed asynchronous digital computer simulator utilized in the Air Traffic Control program. Directed activities of a group of engineers and technicians. Tasks included: Analysis and design of control logic for flexowriter, paper tape punch, photoelectric paper tape reader, and sequential access high-speed core buffer. Similar function with regard to a large group of input-output and data checking instructions and their associated subroutines.

Proposed and designed a four-phase clock and monitoring system utilizing high-speed dynamic logic.

Performed phase-state logic design analysis of digital sub-systems designed for the Terminal-Transition portion of the Air Traffic Control Program.

Responsible for system checkout and integration of a digital-to-analog cathode-ray tube display device used as a direct readout of computer generated information. Formulated system alignment techniques based on electro-optical characteristics of display tube.

Memberships

- I.E.E.E. Professional Group on Electronic Computers
- I.E.E.E. Professional Group on Space Electronics and Telemetry
- I.E.E.E. Professional Group on Communications System

Publications

"Data Acquisition and Processing System for the NIMBUS Meteorological Satellite", Proceedings of the National Telemetry Conference, May 1963.

"VOCOM-A Multichannel PCM Voice Communication Link", Graduate study performed for Masters credit, City College of New York, 1962.

FRANK W. GALLAGHER

Staff Engineer

Education

Graduated in 1957 from the Advanced Technology Course (T-3) at RCA Institutes.

Presently completing requirements for a B.S.E.E. Degree at Hofstra College.

Successfully completed formal courses in Computer Programming and Logic Design conducted by GPL Division, General Precision, Inc, in conjunction with the Air Traffic Control Data Processor.

Experience

August, 1960 to Date- ESS GEE, Inc, Elmsford, New York
Staff Engineer

Presently engaged in the design and development of digital products. These products include an EPUT meter and a line of digital printed cards for operation in the 1-10 megacycle range.

Responsible for the system study and logic design of an electronic digital clock synchronized with Radio Station WWV to provide real time to the FAA Air Traffic Control Data Processor.

Designed the logic necessary to provide a digital printer output channel to an airborne digital data recording system designed for the United States Weather Bureau.

Responsible for the system study, logic design, implementation, and test of the Flight Data Console Adapter Unit. This unit made it possible for the Flight Data Console, originally designed as a buffered device, to be employed as an "on-line" device with the Air Traffic Control Data Processor. The Adapter Unit accepted the character serial, bit serial output messages of the ATCDP and converted these outputs to character serial, bit parallel inputs for the Flight Data Console. The Adapter Unit also accepted the character serial, bit parallel input messages of the Flight Data Console and converted these messages to character serial, bit serial inputs to the ATCDP.

Conducted study to prove the feasibility of connecting a line printer to the ATCDP without modifying the existing design.

ESS GEE, Inc.

Frank W. Gallagher (cont'd)

Responsible for the logic design and assisted in the circuit design of a transistorized decade counter with incandescent lamp display.

June, 1957 to August, 1960 - GPL Division, General Precision, Inc,
Pleasantville, New York

Associate Member

Responsible for the system study, logic design, implementation, and test of the High Speed Punch Unit. This device provided the FAA ATC Data Processor with a digital data recording rate 60 or 240 characters per second.

Provided a detailed description of the operation and use of each command of the ATC Data Processor for the ATCDP Programmer's Handbook.

Assisted in the monitoring function performed on the logic design of the following areas of the FAA ATC Data Processor: arithmetic unit, paper tape input and output, typewriter input and output, peripheral equipment input and output, and the test programming effort including checkout and diagnostic routines.

MARVIN ROBINSON
Staff Engineer

Education

Lehigh University, Bethlehem, Pennsylvania
B.S.E.E. Bachelor of Science in Electrical Engineering
B.S.M.E. Bachelor of Science in Mechanical Engineering
ETA Kappa Nu Electrical Honorary Fraternity
Pi Tau Sigma Mechanical Engineering Honorary Fraternity
Tau Delta Phi Social Fraternity
A.I.E.E. and A.S.M.E.

Graduate Studies:

University of Buffalo, Buffalo, New York
Columbia University, New York, New York
Westchester Community College, Valhalla, New York

Experience

Westinghouse Electric Corporation

Had assignments at various Westinghouse Divisions: power transformer development, mercury lamp development, lightning arrester testing, and relay circuits, and the Westinghouse Design School.

Motor and Control Division, Buffalo, New York

Designed dc motors, designed transformers, rectifiers, regulators and the assembled control circuits using various relays for regulated industrial power supplies and wrote up instruction booklets describing normal circuit operation.

U. S. Army Signal Corps Labs (while in service)

Electro-Mechanical Lab Section
Fort Monmouth, New Jersey

Tested the "Honest John Missile" XYH Ground Support Equipment Recorder, conducted final running recorder plots, wrote instruction booklet describing the purpose, manual operation, maintenance, and functional and detailed theory of operation of the

ESS GEE, INC.

Marvin Robinson (cont'd)

XYH Recorder, did routine field radar interference tests, helped to track missiles while on a destroyer in the Atlantic Ocean.

United Aircraft Corporation

Norden Labs
Gyro Department
White Plains, New York

Did calculations for stress analysis and heat transfer problems, tested four bomb director gyro units, investigated Scott T-transformer, E-transformer sensitivity, and designed cathode coupled multivibrator.

ESS GEE, Inc.

Elmsford, New York

Calculated passive elements for a transistorized logic multivibrator design, designed multi-stage transistorized chopper amplifier, worked on a transistorized remote meter reading system.

HOWARD J. LILIENFELD
Senior
Staff Engineer

Education

Bachelor of Electrical Engineering, 1958, New York University
Master of Electrical Engineering, 1959, New York University
U. S. Army Guided Missile School, Six-month course completed May 1953, Fort Monmouth, New Jersey

Experience

1962 to Present - Senior Staff Engineer at ESS GEE, Inc.

Mr. Lilienfeld has been engaged in the design of special circuitry for the NIMBUS High Speed Data Acquisition and Processing Systems. This included the design of differential amplifiers, power supplies, gridding signal generators, phase lock loops, and various digital circuits. He also designed the circuits for the synchro-to-digital converter, and acts as consultant on various design problems involving special circuits.

1959 to 1962 - Staff Member of GPL Division, General Precision, Inc, Pleasantville, New York

Mr. Lilienfeld held responsibility for the technical supervision of the Microwave Link Program. This involved transmitter and receiver electronic design encompassing power supplies, video amplifiers, AF circuits, discriminators, microwave components, etc.

He was also engaged in the design and development of ground support test equipment for various Airborne Navigational Doppler Systems, and in the design and analysis of airborne servo amplifiers for the RADAN 500 system. In addition, he designed circuitry for the frequency tracker of the AN/ASQ-28DRE (B-70 aircraft) doppler system.

1958 to 1959 - Teaching Fellowship in Electrical Engineering Department of New York University - Thesis: Binary Transmission Employing Null Zone Reception

1955 to 1958 - Undergraduate at New York University

1954 to 1955 - Project Engineer with Commercial Radio-Sound Corporation, New York, New York

Howard J. Lilienfeld (cont'd)

Mr. Lilienfeld designed various audio systems to meet specification requirements for schools, churches, transportation terminals, etc.

1952 to 1954 - Chief of External Guidance in Guided Missile Guidance Control Repair Section of U. S. Army

He supervised the maintenance and repair of the guidance station for the Corporal Missile.

Specific Applications

1. Vacuum Tube Circuitry

Direct Current Amplifiers
Feedback Amplifiers
Regulated Power Supplies
Intermediate Frequency Amplifiers
Video Amplifiers
Audio Amplifiers
Automated Frequency Control Circuits
FM Discriminators

2. Transistor Circuitry

Feedback Amplifiers
Servo Amplifiers
Position Servomechanisms
Flip-Flops
Diode Modulators
Diode Demodulators
Timing Circuits
Switching Circuits
Relay Drivers

GEORGE J. SCHILLERStaff EngineerEducation

B. S. in Mechanical Engineering, 1957, City College of New York
Graduate studies towards M. S. in Electrical Engineering, Columbia
University (Specialization-Digital Systems)

Experience

October 1962 to present - ESS GEE, Inc.

Mr. Schiller is presently responsible for the design of data acquisition systems for the Nimbus weather satellite program. Additional responsibility includes the supervision of all phases of the design, fabrication, and installation of other data handling systems.

1961 to 1962 - Electronic Systems Division, General Time Corporation -
Senior Project Engineer

At General Time, he was responsible for the design, development, and manufacture of many types of electronic systems. As supervisor of a group of engineers and technicians, he had responsibility for projects in the following areas:

1. Satellite Timing Programming Systems.
2. Ground Based Satellite Programmers.
3. Industrial Data Acquisition Systems.
4. High-Shock Electronic Packaging.
5. Shell Timing Arming Systems.
6. Solid-State Circuit Development Including Magnetic Oscillators, Switching Circuits, and Memory Devices.
7. Development of a Rotary Solenoid.
8. Magnetic Logic Elements.

1957 to 1961 - GPL Division, General Precision, Inc, Pleasantville,
New York - Staff Engineer

Mr. Schiller, while at GPL, was actively engaged in the design and

analysis of various phases of Doppler Radar and Air Traffic Control Systems. His tasks included the design and development of systems in analog and digital fields. The design of electromechanical servomechanisms employing synchros, resolvers, and associated gearing were included among his functions.

His work on Air Traffic Control included responsibility for check-out and design assistance on a major flow control console. In this connection he gained experience in the following areas:

1. Analog to Digital Conversion.
2. Magnetic Shift Registers.
3. Binary Logic.
4. Digital to Analog Conversion.
5. Data Processing and Display.

An additional task involved the design, installation, and field test of a digital data recording system for use on nuclear submarines. This encompassed work on such devices as shaft encoders, paper tape punches, magnetic storage components, and data acquisition techniques.

June 1956 to September 1956 - International Business Machines Corporation, Poughkeepsie, New York - Staff Engineer

With IBM, Mr. Schiller designed and developed various computing mechanisms for use on advanced data handling devices.

Societies

Institute of Radio Engineers
American Society of Mechanical Engineers
Pi Tau Sigma

RANDALL G. HILLComputer EngineerEducation

January, 1958 to May, 1959 - University of Dallas
Major-Pre-Engineering
July, 1956 to June, 1957 - Rem-Rand Univac Service Schools
All Computer and associated type
classes available.
December, 1952 to August, 1953 - Navy AT"A" School, Memphis
Programming and maintenance courses.

Experience

October 61 to Present - Ess Gee, Inc.
Computer Engineer

Duties:

1. Shift Supervisor in the installation and maintenance of the FAA/ATC DP Equipment.
2. Diagnostic Programming.
3. Logic Analysis for programming, test specification, maintenance, and systems status reports.

April, 1961 to October, 1961 - McCracken Associates, Inc.
Instructor-Computer Design & Maintenance

Organized and instructed a series of two-week courses on the FAA/Data Processing System Logic Design covering the computer, files, flexowriter, and Input-Output devices. The courses were designed to provide FAA personnel with a basic understanding of the design of the ATC DPC equipment and the application of Sheffer Stroke Logic to this design. In addition, instructed a series of five-week courses on the ATC DP File Drum Maintenance. This included a complete coverage of the file drum operation, design, and maintenance techniques.

July, 1959 to April, 1961 - General Precision Laboratory, Inc.
Assistant Staff Member, Computer Engineering

Shift Supervisor in the installation and maintenance of the FAA/ATC DP equipment. Responsibilities included "floor" supervision of all

maintenance effort, diagnostic programming procedures used, and on-line maintenance operations.

July, 1956 to July, 1959 - Rem-Rand Univac
Systems Engineer

Duties: Maintenance of the Univac 1103A computer system, including the Central Computer, Card-to-Tape Converter. Tape-to-Card Converter, High-Speed Printer, Magnetic Tape Units, and various external units.

May, 1952 to July, 1956 - U. S. Navy
Aviation Electronic Technician

Duties: Maintenance of all electronic airborne equipment, including communication, radar, and IFF gear. Responsible for all radar maintenance efforts on (at last duty station) APS-20, APS-15, APX-15, etc., including training, "on-job" type.

ALAN COHEN

Manager of Publications

Education

and Security Officer

B. S. in Journalism, 1948, University of Illinois
Degree in Basic Engineering, 1944, Texas Western University
Electronics Courses, 1958 - 1959, Westchester Community College
Commercial, Color, and Portrait Photography, 1948 - 1949, School
of Modern Photography
Supervisory Development Seminars, Phases I and II, 1962, General
Dynamics/Astronautics

Experience

1959 to 1962 - Supervisor of Records, Production, and AGE/TIF
Groups within the Product Support Publications Department of GD/
Astronautics, San Diego, California

Mr. Cohen held supervisory responsibility for the following
functions:

- (1) Preparation and publication of service bulletins covering servicing and modifications to the Azusa and Glotrac Transponder and Checkout equipments located at AMR, PMR, and other sites.
- (2) Preparation and publication of AGE Figure-A and Figure-1 lists and revisions for both operational and R & D equipment of various missile systems including Atlas and Centaur.
- (3) Preparation and publication of the bi-weekly Field Service Newsletter.
- (4) Preparation and publication of Technical Information File (TIF) data sheets for nation-wide distribution.
- (5) Maintenance of departmental coordination with cognizant functions of San Bernardino Air Materiel Area (SBAMA) via resident representation.
- (6) Maintenance of Service Action and Documentation Group coordination with AFPRO, Contracts Department, Logistics Department, and Engineering Liaison and Release Departments.

Alan Cohen (cont'd)

- (7) Maintenance and Control of records, files, security matters, direct and indirect labor summaries, production, and distribution for the items listed above and for TCTO, Service Action Parts List, and Service Action ECP Exhibit preparation.
- (8) Preparation of work statements and estimates for all of the above.
- (9) Continual provision of inputs for automated preparation of Air Force Ballistic Missile Division - Atlas Configuration Accounting Exhibits and ECP/Change Identification Control/TCTO Cross Index.
- (10) Preparation and provision of Monthly Manpower Forecasts based on Program Planning Grounding Rules.

While with GD/Astronautics, Mr. Cohen was individually responsible for the following accomplishments:

- (1) Establishment of TCTO specification deviation format that provided for publication expedition and economy in a program involving over 400 technical orders.
- (2) Preparation of a procedures and style guide on the preparation of military and commercial modification publications.
- (3) Development, establishment, and coordination of a data collecting, recording, and status reporting system and procedure to enable the complete surveillance of the several hundred active and pending publication tasks supporting the Atlas ICBM modification program.
- (4) Issurance of an automated cross index which correlated TCTO numbers to the respective ECP and CIC numbers.

1956 to 1959 - Assistant Group Leader of Manuals and Documentation Group of GPL, General Precision, Inc, Pleasantville, New York

Mr. Cohen functioned as prime assistant in the development of a manuals program to support the FAA/BRD Traffic Control System. This involved the preparation of work statements and estimates, and the submittal of RFQ's to associate contractors. He also prepared the original handbook specification from which involved FAA Specification ER-D-370-009.

Prior to this, he was group lead assistant on all preparational phases of the Seamaster Doppler Navigational System handbooks (1500 pages). His responsibilities included text, art, and repro quality control; maintaining coordination with NYAPD; monitoring vendored tasks; and the preparation of various operation, service and overhaul technical orders.

Memberships

National Management Association, Alpha Delta Sigma (National Honorary Advertising Fraternity), Rotary International (1951 - 1956), Photographers Association of America (1948 - 1956), Society of Technical Writers and Publishers (Inactive)

ESS GEE, Inc.
White Plains, N.Y.

PP

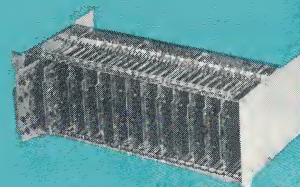
PROPRIETARY
PRODUCTS



1 HOLLAND AVENUE

WHITE PLAINS, N. Y.

(914) WH 6-1200



TECHNICAL BULLETIN

NO. 2-103
DATE: June 1964

R A D I C A L

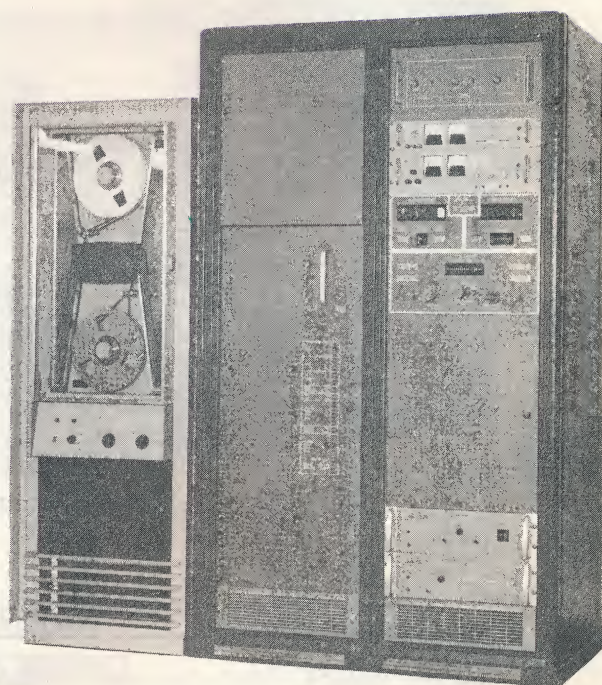
RAPID ANALOG-TO-DIGITAL CONVERSION AND LOGGING SYSTEM (MODEL 4001)

This system scans, digitizes, and records multiple analog input data with a high degree of accuracy at rates up to 15,000 samples per second.

Additional design features include preset, selectable time accumulation, visual data display for any selected channel, fixed information selector switches and programmable channel selection to preset increments of the total available channels. Equipment downtime is minimized since difficulties in the system are readily localized by the use of a manual "single" clock switch. This utility permits the logic circuits to be stepped through the normal modes of operation.

Core buffering offers the advantage of tape recording, independent of the scan rate, and efficient tape usage in fully compatible IBM format.

ESS GEE's design criteria for system components and complete instrumentation installations is application versatility with optimum system performance.



SPECIFICATIONS

INPUT

Analog: ± 10 volts
Up to 256 channels
(blocks of 8)
Digital: 9 BCD characters -
fixed data
5 BCD characters -
elapsed time clock

OUTPUT

Format: 200/556 bpi
IBM format
3/4" EOR gap & file gap
Full parity
Selectable length of record
Data: 13 bits plus sign, binary, or
4 BCD characters plus sign

(continued)

data processing and instrumentation

SPECIFICATIONS

SCAN OPERATION

Modes:

Single Step Channel Advance
Automatic Single Scan & Stop
Automatic Continuous Scan
Calibration Scan

Typical Sample Rate:

100 samples per channel per sec

SYSTEM ACCURACY

Short Term Maximum Error:

$\pm 0.03\%$ FS $\pm 1/2$ digit for 3 sigma
all readings, P-P

Long Term Maximum Error:

$\pm 0.05\%$ FS $\pm 1/2$ digit for 3 sigma
all readings, P-P

VISUAL DISPLAY

Elapsed Time Clock:

Decimal Readout - One-second Resolution
Remote or local reset

Channel Readout:

Monitor any selected channel during scan

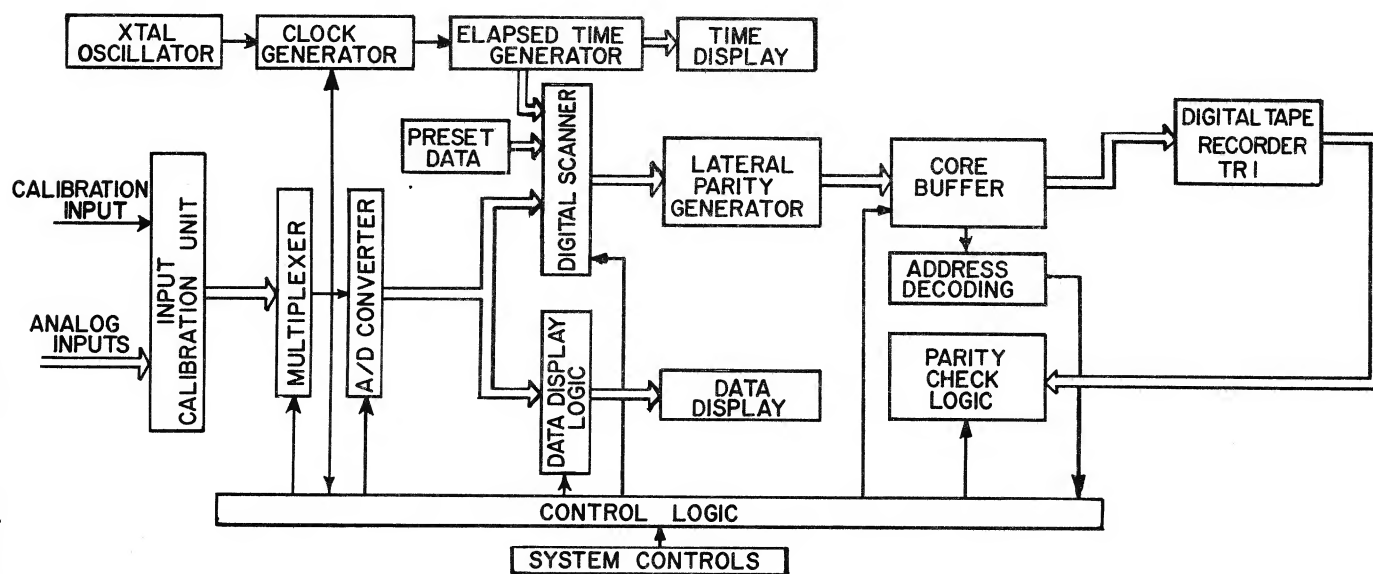
Indicator Panel:

Monitor system sequence - calibration

PHYSICAL DIMENSIONS

Dual Console: 76"H x 46.5"W x 25"D

Recorder: 69"H x 25.5"W x 27"D
(typical)



SYSTEM FUNCTIONAL BLOCK DIAGRAM

OPTIONS

Tape Parity Check: "Read after write" parity check of all data on tape.

Performance Analyzer: Automatic system check compares the converted data values on tape to a preset input voltage.

Channel Selection: Program any increment of the total available channels.

Digital Inputs: Additional inputs available (Keyboard, Code Wheel, Counters, etc).

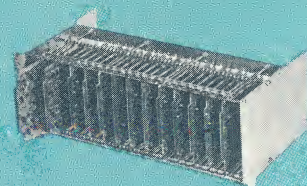
Higher Scan Rates: Available for the Model 4001 System.



1 HOLLAND AVENUE

WHITE PLAINS, N. Y.

(914) WH 6-1200

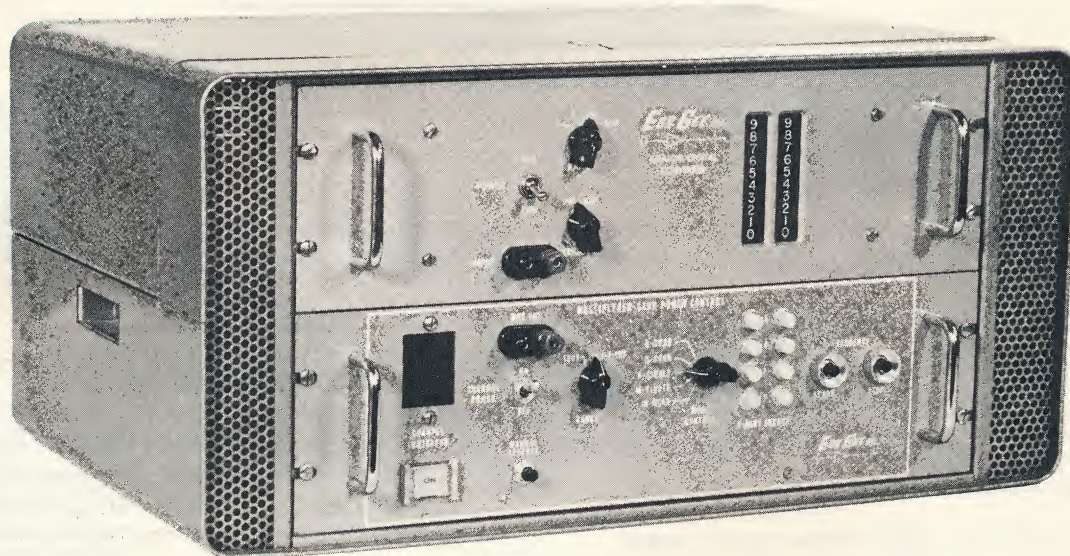


TECHNICAL BULLETIN

NO. 2-102A

DATE: December 1963

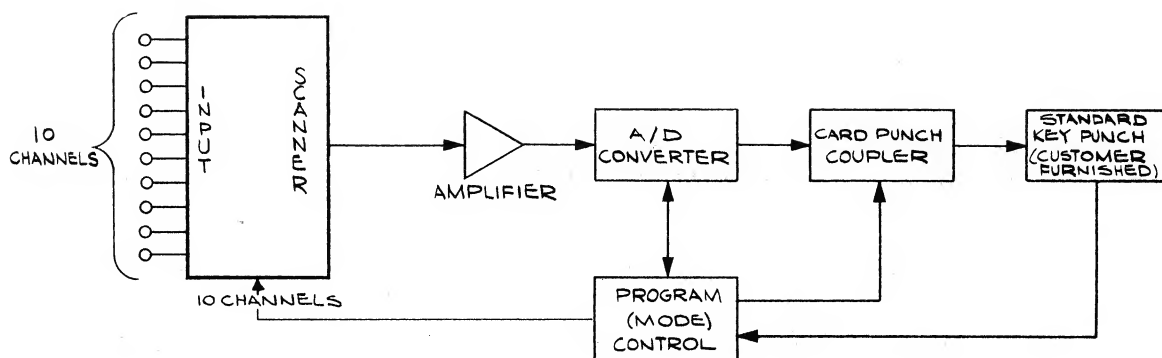
MULTI-CHANNEL DATA ACQUISITION AND DIGITAL RECORDING SYSTEM (MODEL 1043)



● Economically Priced at \$3590

- Portable
- Modular Construction
- All Solid-State Logic
- Remote Operation Controls
- 5 Modes of Operation
- Rapid Mode Selection
- 0.5% $\pm 1/2$ bit Accuracy
- Automatic/Manual Card Punch Output
- Any Analog Signal Input (100 V Range)
- 10 Data Channels (Optionally Expandable)
- Identifies Each Channel
- Scans 6 Channels/Second
- 10 Channels/Second Max Recording Rate
- Two-decimal Digit & Binary Displays

data processing and instrumentation



SPECIFICATIONS

NUMBER OF DATA CHANNELS

10 (expandable to 26)

OUTPUTS

- 2-digit data output for card punch
- 1-digit channel ID punch
- 2-decimal digit & binary displays

MEASUREMENT ACCURACY

0.5% of full scale $\pm 1/2$ least significant digit
(optional: 0.1% $\pm 1/2$ bit)

OPERATING MODES

- Continuous Scan
- Single Scan
- Automatic Single Channel
- Manual Single Channel
- Manual Scan

VOLTAGE RANGE SELECTION

0 to 100 mv, 0 to 1 V, 0 to 10 V,
and 0 to 100 V

CHANNEL ID INHIBIT

Manual switch operation

RECORDING RATE (as limited by key punch operation)

6 per second of 2-digit data plus channel ID, or
10 per second of all 2-digit data

FIXED DATA ENTRY (optional)

3 decimal digits, or more

COMMON MODE VOLTAGE REJECTION

200 volts

INPUT POWER

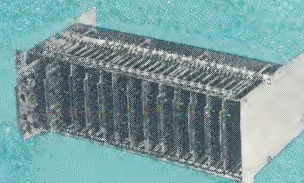
117 V $\pm 10\%$, 60 cps

CABINET

Grey hammertone finish
Recessed carrying handles
Size: 11-1/4 x 24 x 15 inches
Total weight: appx 70 lbs

ACCESSORIES

10 dummy connectors
Key punch interconnection cable and receptacle
Instruction manual

**TECHNICAL BULLETIN**

NO. 2-102B

DATE: December 1963

**MULTI-CHANNEL DATA ACQUISITION
AND DIGITAL RECORDING SYSTEM
(MODEL 1043)****DESCRIPTION**

ESS GEE's Multi-Channel Model 1043 Data Acquisition and Digital Recording System is a compact, portable unit consisting of an Analog/Digital Converter, Model 1022, and a combined Multiplexer - Card Punch Control. It constitutes a low-cost data collection system which affords the economy of combining multiplexed data input channels from 10 independent sources with an automatic data recorder. As an option, it can be expanded to accommodate up to 26 data input channels.

The system is comprised of completely solid-state and electromechanical components, using modular construction, for high reliability. Circuitry is designed for "worst-case" tolerance conditions, and all components are operated well below their maximum ratings.

OPERATION

Input signal sources are connected to the system at receptacles provided on the rear panel. Dummy connectors are provided for the unused receptacles. The scanner, in its sampling process, skips past those channels which are dummy connected.

The system is capable of measuring, displaying, and recording voltages in any of four ranges as manually selected. It accepts balanced or single-ended analog information from the data input channels, and converts it to two-digit BCD format. The selected input signal is amplified by a DC differential amplifier possessing the capability for rejecting large magnitudes of common mode voltage. The gain of this amplifier suffices to amplify millivolt signals to magnitudes of volts. The amplified signal output of this amplifier is the input to the A/D Converter. The BCD outputs from the A/D Converter are converted to a decimal format, and are then punched as digits on cards with the aid of a standard key punch machine. Card spacing and card ejection are automatic programmed operations of the key punch machine.

OPERATION (cont)

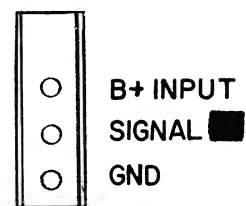
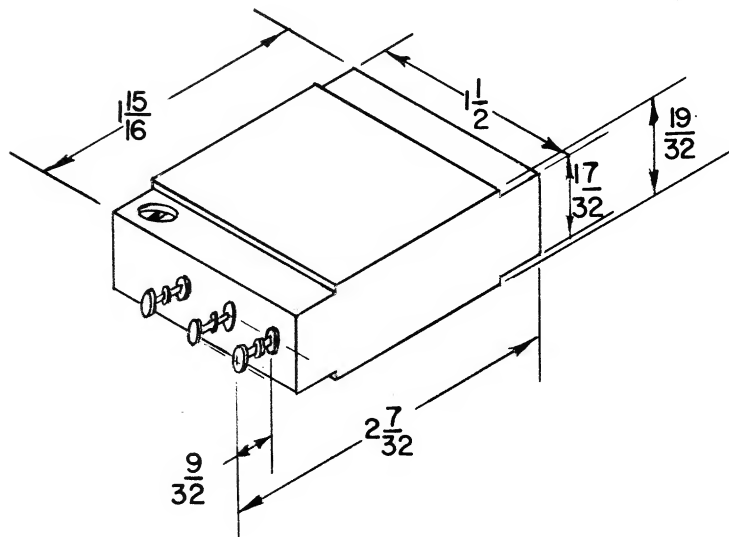
In addition to the two-digit outputs, representative of the input data, the system records and displays a single-digit identification of each channel. This channel identification, which is the recorded position of the channel selector stepping switch, to some degree slows down the over-all recording process. A CHANNEL PUNCH disabling switch is provided for obtaining faster operation when desired. The provision for manual insertion of up to 3 (or more) digits per record is available as an option.

The system enables manual selection of five modes of operation:

- Continuous Scan mode provides repeated sequential samplings of all data input channels. The scanner cycles to channel one when the SEQUENCE START pushbutton is depressed, and a start pulse initiates the A/D conversion process. In less than 5 milliseconds, an end-of-conversion pulse is emitted to activate the key punch equipment, and the 2 digits of input data and 1-digit channel identification are card punched and printed. Concurrent with the recording of the first digit, the scanner advances to the next input and the recording operation is repeated. This continues until the SEQUENCE STOP pushbutton is depressed.
- Single Scan mode provides one sequential sampling of all data input channels with each depression of the SEQUENCE START pushbutton.
- Automatic Single Channel mode enables manual advance of scanner to a desired data input channel which is continually measured and recorded until the SEQUENCE STOP pushbutton is depressed.
- Manual Single Channel mode also enables manual advance of scanner to a desired data input channel; however, this one input is measured and recorded only with each depression of the SEQUENCE START pushbutton.
- Manual Scan mode is similar to the Manual Single Channel mode, except that after each depression of the SEQUENCE START pushbutton, the scanner automatically advances to the next input.

NOTE: The OSCI-PLUG can be manufactured with or without internal crystal mounting in the configurations shown below.

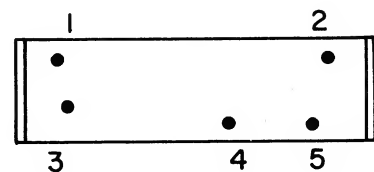
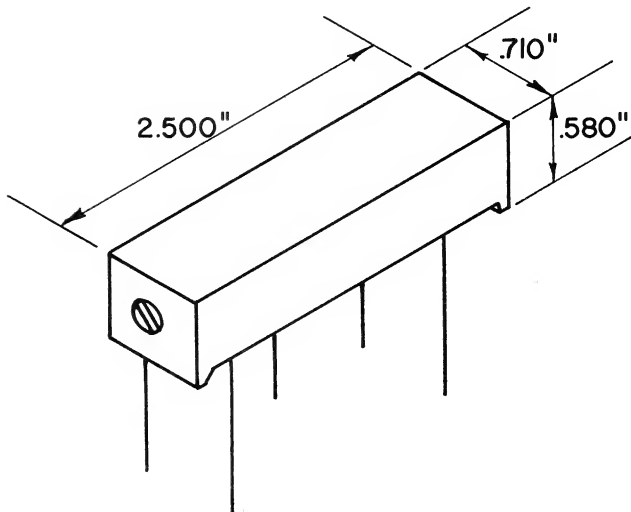
TURRET TERMINAL TYPE



TERMINAL
CONNECTORS

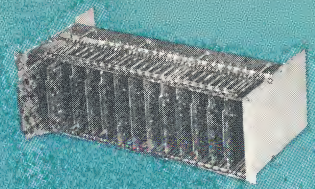
DIMENSIONAL OUTLINE

FOR PRINTED CIRCUIT CARD MOUNTING WITH EXTERNAL CRYSTAL



PIN CONNECTORS

DIMENSIONAL OUTLINE



TECHNICAL BULLETIN

NO. 3-101
DATE: January 16, 1962

ENVIRONMENTAL CIRCUIT CARD TESTER

Model No. 1002

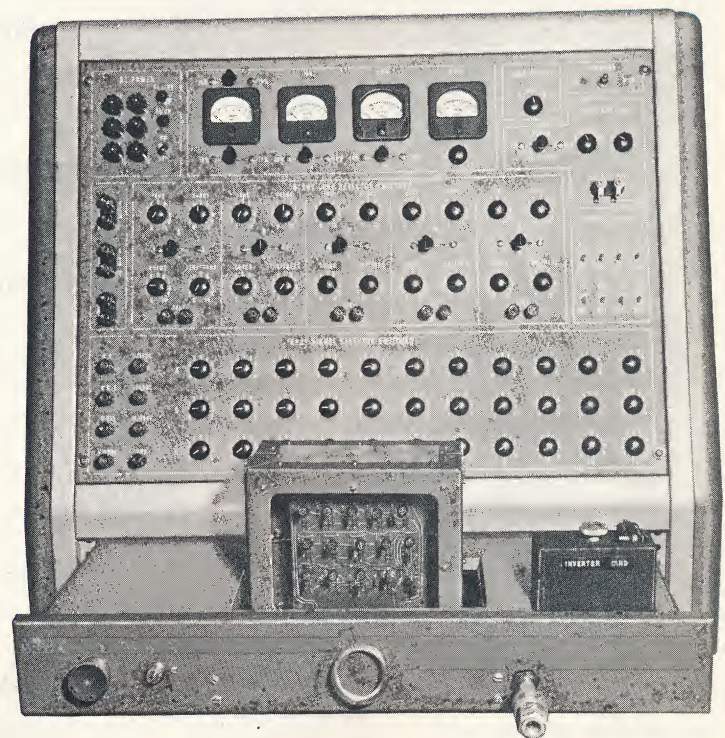
ESS GEE, Inc, has developed a Printed Circuit Card Tester capable of simulating a variety of environmental operating conditions.

The unit incorporates a high temperature Plexiglas test chamber that mounts over the card during test. By means of a heating element in the air stream of a fan it is possible to raise the temperature inside the chamber from ambient to +185°F.

Cooling is accomplished by feeding liquid CO₂ from a standard 50 lb. bottle through a six foot length of high pressure hose into the test chamber. This temperature may be lowered from ambient to -50°F.

The temperature through all ranges is regulated by a vernier controlled, micro-switch activated, bulb type thermostat mounted on the same drawer as the test chamber.

The card connector and test chamber are mounted on a motor driven platform which, when activated by the vibrator switch located on the



data processing and instrumentation

control panel, will produce acceleration loads of 2G's or 5G's.

Inputs to the card under test may be either a voltage level, pulse or any other wave shape that can be generated by an external signal generator. Voltages are provided from power supplies within the card tester. External signals are provided from pulse generators, etc., through the pulse generator posts #1 and #2 located on the control panel. These voltages and signals are connected to the card by means of the Input Selector Switches and a patch connector.

There are five banks of load resistors controlled by the output load selector switches. Each bank has four switches covering the ten, hundred, thousand, and ten thousand ohm ranges in ten ohm steps. This enables the operator to simulate the "in system load" of the card under test.

The tester has voltmeters on the front panel to monitor the power supplies and each meter has a marginal checking switch mounted with it. This provides a means of varying the applied voltages $\pm 10\%$.

SPECIFICATIONS

Power: 115 V 60 cps, 950 watts

Dimensions: 27 inches high, 30 inches deep, 28 inches wide

Weight: 125 lbs.

Environmental:

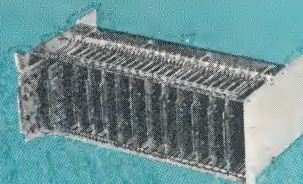
Temperature: -50°F to $+185^{\circ}\text{F}$
Acceleration: 2G or 5G
DC Voltage-
Supplies: to customer specifications
Resistance-
Load Range: 0 to 100,000 ohms
Printed Circuit-
Type: to customer specifications



1 HOLLAND AVENUE

WHITE PLAINS, N. Y.

(914) WH 6-1200



TECHNICAL BULLETIN

NO. 1-117
DATE: March 1963

SILICON TRANSISTOR LOGIC CARD SERIES 1026

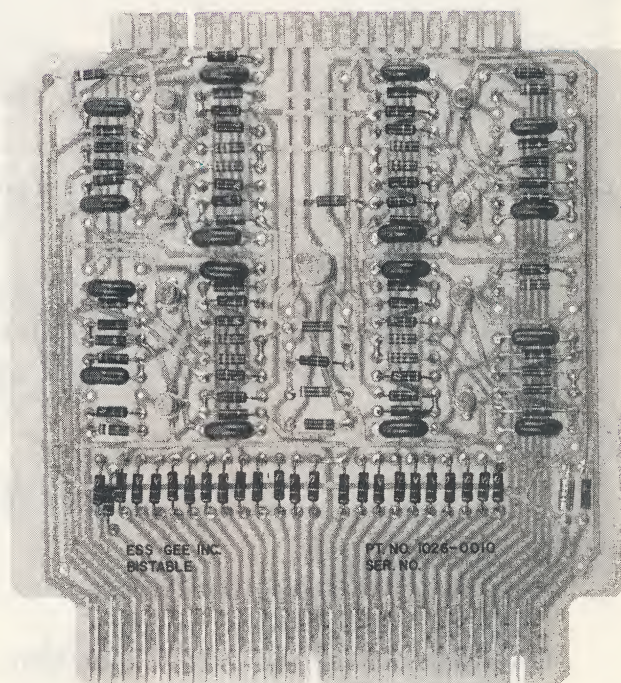
- BISTABLE CARD -

(PART NUMBER 1026-0010)

The Series 1026 Bistable Card contains four flip-flop circuits and a clock driver. The circuits are operable up to a frequency of 1.2 megacycles under normal load. Each flip-flop circuit is capable of driving succeeding flip-flops without the use of intermediate stages.

A built-in fixed time delay feature provides an extremely high immunity to ambient electrical noise. Gated set and reset inputs respond only on the trailing edge of the clock pulse. Any spurious signals of less than 0.1 usec duration, regardless of amplitude, cannot trigger the flip-flops. The flip-flops will always respond to a pulse of 0.35 usec or longer duration.

ESS GEE Series 1026 Logic Cards use silicon transistors exclusively. All circuitry is designed for "worst-case" tolerance conditions and all components are operated well below their maximum ratings to insure reliable and maintenance-free operation. The cards are particularly well suited to extreme environmental application, and are operable over a temperature range of -55°C to $+85^{\circ}\text{C}$. All outputs are returned to rhodium-plated contacts at the top of each card to facilitate testing. The printed circuit board material is G-10 glass epoxy and a low-resistance connector (Elco varicon type) is used to insure positive contact and to eliminate problems inherent with use of other connector types.



ESS GEE, Inc, carries a complete line of silicon or germanium transistorized printed circuit logic cards.

data processing and instrumentation

SPECIFICATIONSCard Configuration:

- 4 flip-flop circuits
- 1 clock driver

Input:

- Common clock
- 3 input set gates per flip-flop (3 MA/GND)
- 3 input reset gates per flip-flop (3 MA/GND)
- 1 DC reset gate

Levels:

- Positive logic
- "0" = 0V to +1.5V
- "1" = +6.5V to +13V

Power:

- +13V $\pm 5\%$, 140 MA maximum
- 13V $\pm 5\%$, 13 MA maximum

Clock Input:

- | | 55° C | 85° C |
|--|-----------|----------|
| Clock rate (max): | 2 MC | 1.2 MC |
| Pulse width (max): | 0.25 usec | 0.4 usec |
| 80 nanoseconds max trailing edge fall time | | |
| Flip-flop triggered on pulse trailing edge | | |

Loading:

- 8 unit loads max output

Delay plus Fall Time:

- Less than 90 nanosec with 8 unit loads,
100 uuf shunt, -55° C to +55° C
- Less than 125 nanosec with 8 unit loads,
100 uuf shunt, at +85° C

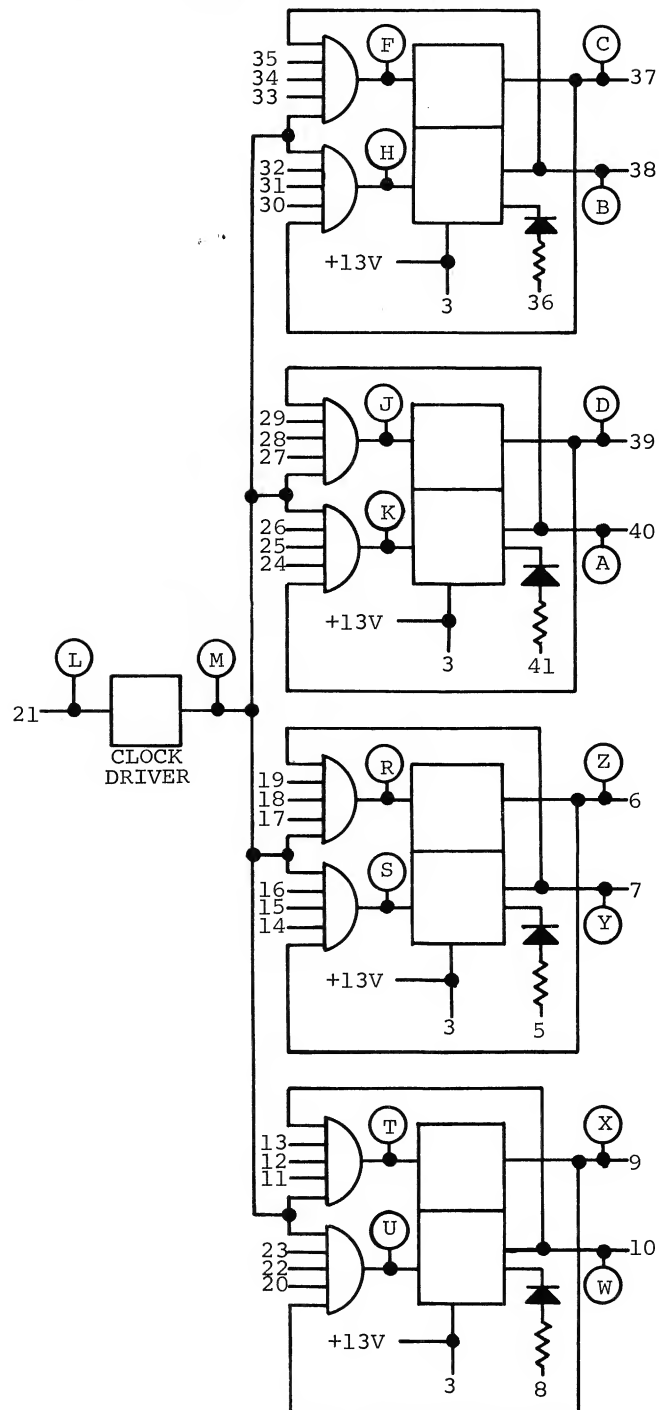
Power Connections:

- Pin #2 -13V
- Pin #3 +13V
- Pin #4 ground

Operating Temperature Range:

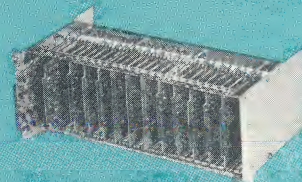
- Full performance at -55° C to +55° C
- Reduced frequency performance to +85° C

PIN CONNECTIONS



Note: Letters indicate test point contacts

* Designed for use with either metal or plastic slides.

**TECHNICAL BULLETIN**

NO.

1-101

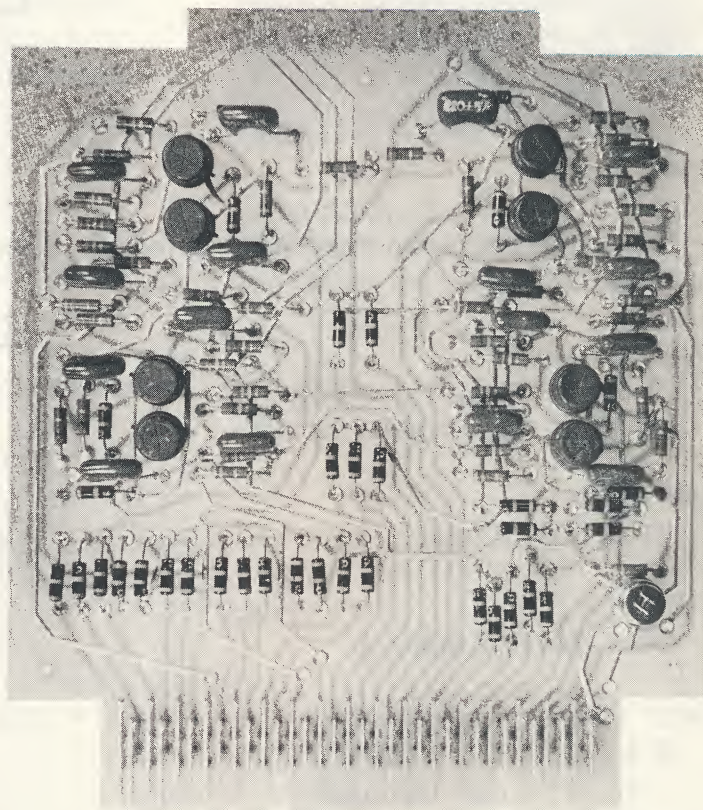
DATE: September 1962

Silicon Transistor LOGIC CARDS Series 1001**— FLIP-FLOP —****PART NUMBERS 1001-004, 1001-004A**

This Flip Flop is operable at a temperature range of -55° to $+85^{\circ}\text{C}$ and will operate under high ambient electrical noise conditions.

Each card consists of four noise-immune flip-flop circuits. Gated set and reset inputs respond only on the trailing edge of a 3 usec. or longer clock pulse. Any spurious signals of less than 1 usec. duration regardless of amplitude cannot trigger the flip-flops. This provides an extremely high noise immunity. Each flip-flop is capable of driving succeeding flip-flops without the use of intermediate stages.

All Ess Gee Series 1001 Logic Cards use silicon transistors. All components are operated well below their maximum ratings to insure reliable and maintenance-free operation. All outputs are returned to the top of each card as a test feature. The printed circuitboard material is G-10 glass epoxy and a low resistance connector (Elco varicon type) is used to eliminate problems which may arise with a standard printed circuit-type connector. This card is particularly well suited to extreme environmental application.



Ess Gee, Inc. carries a complete line of silicon or germanium transistorized printed circuit logic cards.

data processing and instrumentation

SPECIFICATIONS:

Input:

Common Clock
3 Input set gate 1 MA/gnd
2 Input reset gate 1 MA/gnd

Levels:

Positive Logic
"0" = 0V to 3V
"1" = 8.5V to +15V

Power:

+15V, 40 MA Max.
-15V, 1 MA Max.

Clock Input:

Minimum clock width of 2.5 usec. triggers on trailing edge of clock.

Loading:

6 MA Output to positive supply-max. 6 gate fanout.

Rise Time:

less than 2 usec.

Fall Time:

less than .5 usec.

1000 mmf
Load

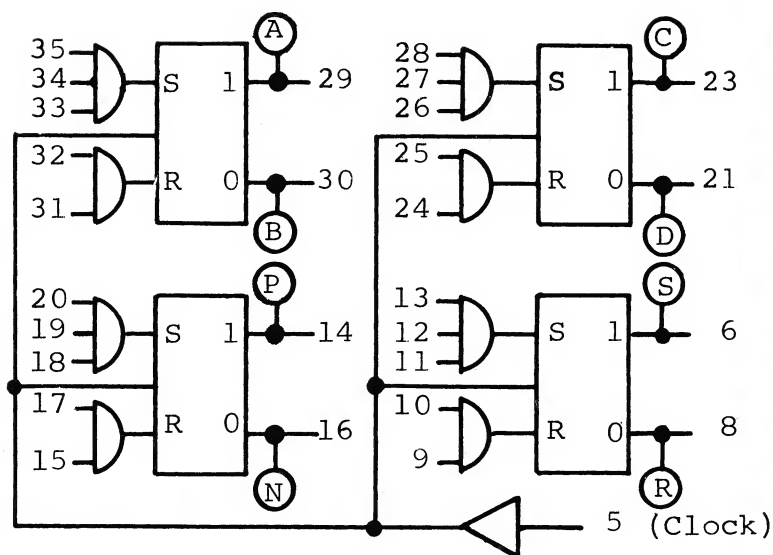
Power Connections:

2 +15V
3 Ground
4 -15V

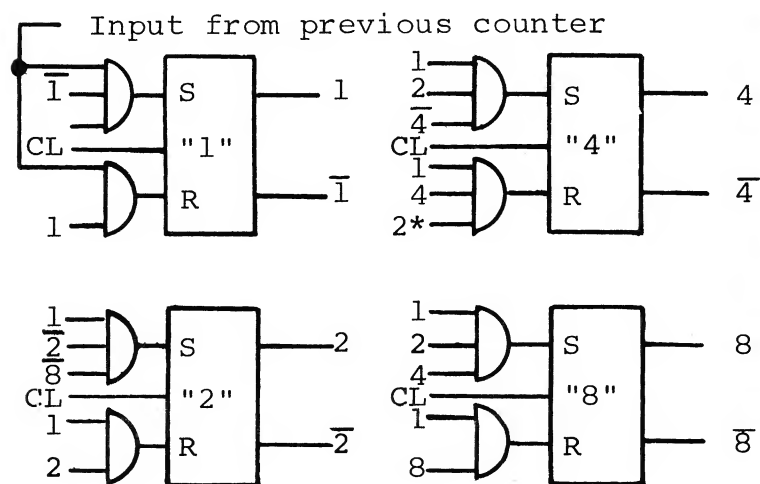
Test Point Connections:

A	P
B	N
C	R
D	S

PIN CONNECTIONS

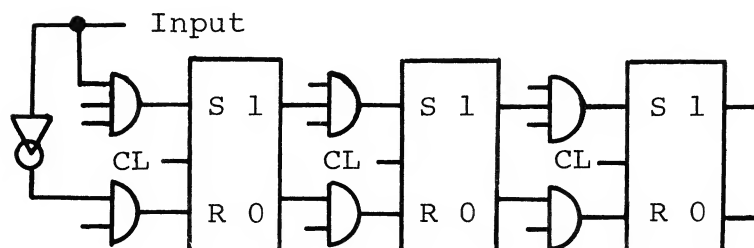


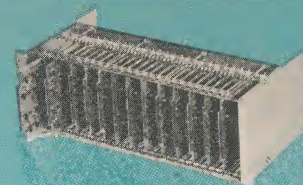
BINARY CODED DECIMAL COUNTER



* This input available on part # 1001-004A

3 BIT SHIFT REGISTER





TECHNICAL BULLETIN

NO. 1-126

DATE: July 1964

SILICON DIGITAL MODULE SERIES 1039

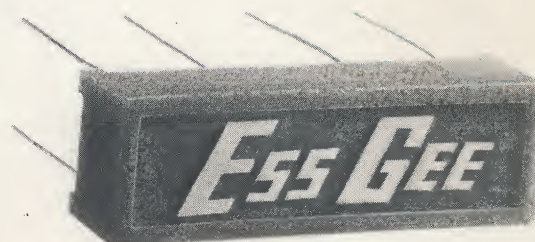
J-K BISTABLE

(PART NUMBER 1039-0002)

This module contains a single transistorized J-K type flip-flop circuit. It operates at frequencies up to 2 mc in T, RS, and RST modes; and is capable of driving 8 unit loads. External "OR" gates driving the set and reset inputs provide application versatility such as shift registers, adders, pre-set binary or decimal counters, ring counters and frequency dividers. Set and reset inputs driven by "AND" gates permit the use of expanded terms when used in conjunction with "AND" gate modules.

Series 1039 modules are completely encapsulated to reduce the environmental effects on the circuit's operation. The epoxy compound prevents "hot spots" from developing as a result of dip soldering or during circuit operation.

The fan-out capability and high switching rates make this bistable element ideal for use in high speed data processing circuits.



SPECIFICATIONS

OUTPUT

"1" = +10.5 to +13 VDC

"0" = 0 to +1 VDC

Drive capability: 8 unit loads*

Fall time: less than 95 nanoseconds with
100 pfd load

Propagation delay: less than 40 nanoseconds

TEMPERATURE RANGE

(Operating)

-55° C to +85° C

(2-mc performance: 0° to +55° C)

POWER REQUIRED

+13 VDC $\pm 5\%$ 34 ma

-13 VDC $\pm 5\%$ 1 ma

INPUT

Switching speed: 0 to 2 mc

TRIGGER INPUT

"1" = +7.5 to +13 VDC

"0" = 0 to +2 VDC

Minimum width: 0.35 usec

Maximum trigger fall time: 80 nanosec

Input load: 3/4 unit load*

SET AND RESET INPUTS

"1" = +7.5 to +13 VDC

"0" = 0 to +2 VDC

Input load: 3/4 unit load*

MODULE SIZE

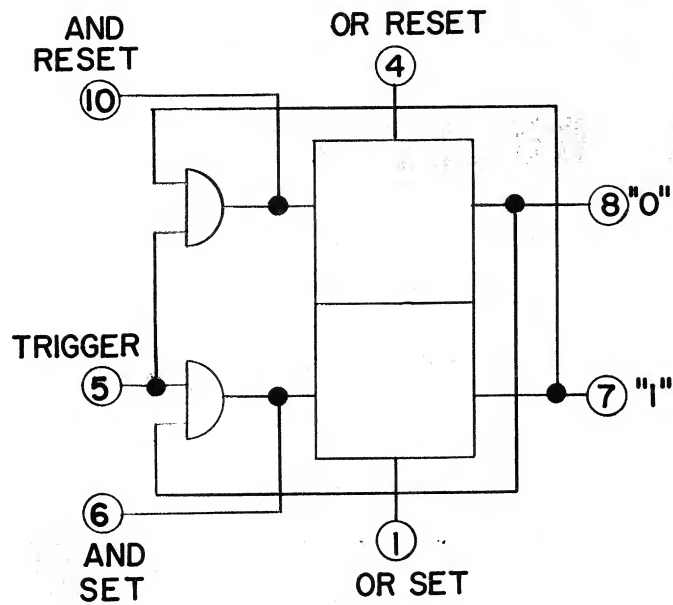
47/64 x 2-1/2 x 37/64

NOTE: Modules are designed for optimum noise immunity and worst-case tolerance conditions.

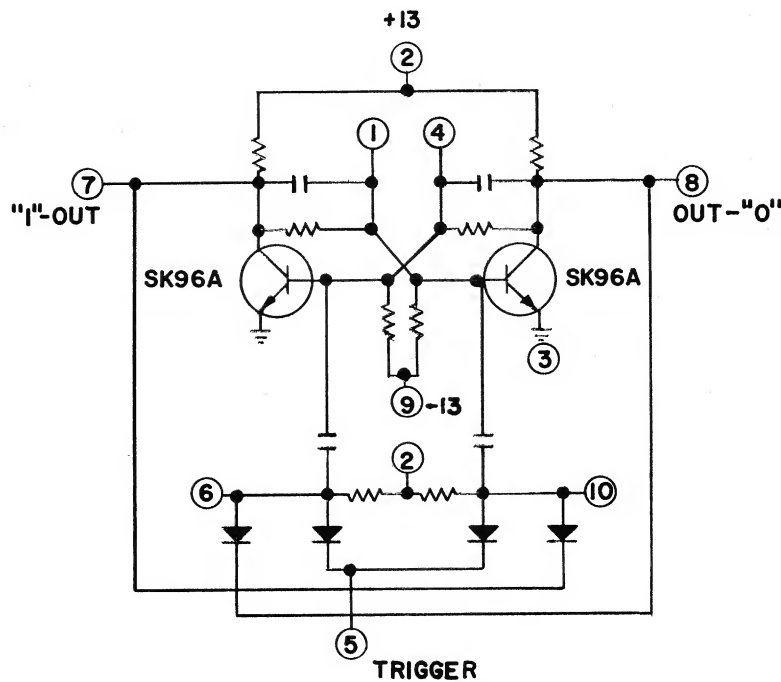
* 1 unit load = 4 ma absorbed from a positive source.

data processing and instrumentation

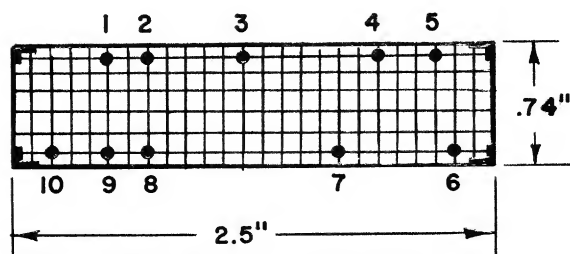
OPTION: External Test Points to facilitate installation and testing.



LOGIC DIAGRAM



SCHEMATIC DIAGRAM



BOTTOM VIEW 0.10 GRID
PIN LOCATIONS

